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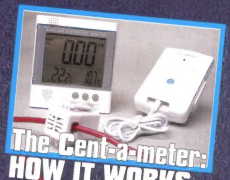

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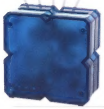

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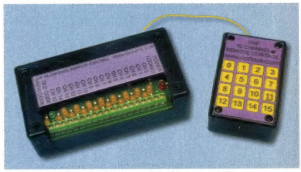

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Publisher & Editor-in-Chief
Leo Simpson, B.Bus., FAICD

Production Manager
Greg Swain, B.Sc.(Hons.)

Technical Staff
John Clarke, B.E.(Elec.)
Peter Smith
Ross Tester
Jim Rowe, B.A., B.Sc, VK2ZLO
Rick Walters

Reader Services
Ann Jenkinson

Advertising Enquiries
Leo Simpson
Phone (02) 9979 5644
Fax (02) 9979 6503

Regular Contributors
Brendan Akhurst
Rodney Champness, VK3UG
Julian Edgar, Dip.T.(Sec.), B.Ed
Mike Sheriff, B.Sc, VK2YFK
Philip Watson, MIREE, VK2ZPW
Stan Swan

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Printing: Hannanprint, Noble Park, Victoria.

Distribution: Network Distribution Company.

Subscription rates: $69.50 per year in Australia. For overseas rates, see the subscription page in this issue.

Editorial & advertising offices:
Unit 8, 101 Darley St,
Mona Vale, NSW 2103.
Postal address: PO Box 139,
Collaroy Beach, NSW 2097.
Phone (02) 9979 5644.
Fax (02) 9979 6503.
E-mail: silchip@siliconchip.com.au

ISSN 1030-2662

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PUBLISHER'S LETTER

CD prices bound to drop

In the last three years or so, sales of audio CDs have declined drastically. As most people are well aware, this has been largely due to the massive increase in copying via computers and the Internet. Whether you are downloading music in MP3 format from the web or just copying CDs in your computer, everyone knows it can be downloaded for a fraction of the price of a new CD in the stores.

This is just another way of saying that the prices of CDs are far too high. Why would anyone willingly pay $20, $30 or more for a full price disc, when you know that someone can get you a copy for next to nothing? And why would you pay $30 for a full price jazz or classical music disc when you can probably get an equally good performance (by a lesser known performer) for $10.95 on Naxos or other low price labels.

Looking at it from another point of view, most people are aware that the production cost of a CD, including its jewel case and printed booklet is around a dollar or so, so why should they pay twenty times that in the shops? People also know that the recording artists typically only get one or two dollars out of a full price disc so there is the very strong feeling out in the marketplace that record companies are just charging too much.

But recently there has been another reason for people to avoid buying CDs and that is the issue of copy protection. Why buy a disc when you know you can't make a direct copy for your own personal use? Or why buy it when you know that copy-protected discs won't play in your car or Walkman or whatever? In fact, there have recently been legal challenges overseas to copy protection. Again, the recording companies are seen as being far too powerful.

Just as I write this editorial, the US company Universal Music Group has announced major CD price reductions and it appears that most other major recording companies will be forced to do the same. Let's hope it is the precursor of major price reductions in Australia too. If Naxos and other low price labels can survive and grow with retail prices around the ten dollar mark, the major companies should be able to reduce their prices by a long way. Doing so would probably cause a major increase in CD sales. It won't stop all copying though.

However, I am sure that faced with a price of $10 to say $15, most people would rather buy the disc with its proper jewel case and printed booklet than use a CD-ROM burnt in their own or someone else's computer. As good as they are, most laser-copied discs are seldom up to the standard set by a pressed disc and there has to be a question mark over the lifetime of a laser-copied disc as well.

And while downloading of MP3 music over the internet is set to continue its exponential increase, the record companies could also do themselves some favours by promoting the quality difference between MP3 and the compact disc standard. Let's face it: unless you are cloth-eared, MP3 simply doesn't sound as good as a good quality well-recorded CD. And if the CD is reasonably priced to begin with, that is all the more reason to buy it.

Leo Simpson

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MAILBAG

Digital television – a complete failure?

I could not let the Publishers Letter in the July 2003 issue pass without comment. Your headline was at best a bit harsh and a few facts are just a little wide of the mark. Your dire prediction of a paucity of television services beyond 2008 is unfounded.

When digital TV started in Metropolitan areas on 1 January 2001, 2008 was selected as the earliest possible date for analog closure in these areas. In light of the uncertainty of how the digital TV rollout would progress, this date was made subject to a review in 2005. In regional areas of Australia where DTTB is currently being rolled out the earliest possible analog termination is 2012, with this date also subject to review.

Initially, all DTTB services will carry standard definition (SDTV) programming which is a wide screen version of the analog service. In quality terms (technical quality that is!), SDTV is at least equal to the best that DVD offers. And the story only gets better as broadcasters introduce HDTV versions of programs. I'm sure your judgment that current SDTV offerings are "low-quality digital signals" has no support among the growing number of digital TV viewers.

If I hark back to the DVD analogy for a moment, we have seen a rapid and significant reduction in the cost of these units over recent months. I believe we are on the edge of a similar slope with digital TV decoder pricing. A quick check of the Digital Broadcast Australia website (**www.dba.org.au**) shows a range of decoders priced from as low as $299 each.

Decoder availability and pricing is subject to chicken and egg syndrome – Australian broadcasters realise this and are aggressively rolling out digital services. And as more digital services become available, demand is growing.

There is much good news in the digital TV story. Australia leads the world in its introduction of free-to-air terrestrial digital TV broadcasting and is increasingly becoming the reference for many other countries on the brink of embracing this technology. We have taken the analog system beyond what was intended with innovations such as stereo audio, teletext and captioning. Like the vinyl record, B&W TV and analog mobile phones, analog TV has gone as far as it can go – it's time to open a new door.

Is Digital TV a complete failure as you suggest? Only to the extent that a newborn baby is a complete failure to create a fully developed adult.

Raoul Prideaux,
Director of Engineering and Technology, Southern Cross Broadcasting (Australia) Ltd.

Set top boxes not foolproof

The "Publisher's Letter" in the July 2003 issue, on the failure of Digital TV to attract more viewers, is mostly correct, except for the price of a Standard Definition STB. There are boxes available from chain stores for under $300. I think Galaxy as the first Pay-TV entity proved that you can't afford to give away a product and expect loyalty from the customer. Just because it's cheap does not make it a good buy!

There are many reasons why the idea has not been embraced, unlike VCRs, mobile phones, etc. Firstly, no one thought about the end user. The Pay-TV companies didn't want multi-views or multi-channels; that would be "free" defacto Pay TV with options not available to them. The FTA broadcasters didn't like the idea of Standard Definition; heavens to be if someone else started up a competitive FTA station using the spectrum the government could have sold off from the analog spectrum.

If you already receive good quality reception, why change? There is no incentive to switch networks unless your TV pictures are poor. There is no guarantee your recent purchase of a STB will work. Because I know from hundreds of hours of experience that unless you can find THE SPOT for the receive antenna, one or more channels refuse to lock in.

The price of a reasonable BER (Bit Error Rate) digital meter is still too high and I rely on my knowledge of antennas and reception theory to get me through the installation. BER is more important in digital transmissions than signal level, as a high signal strength does not necessarily mean a clean signal. The lower the BER, the less prone to dropouts the system will be. I cannot stress enough that Digital is not necessarily a "Plug and Play" item, as promoted by the DBA and retailers.

As a consumer, I don't need Digital to get quality pictures at my abode. But I would embrace the technology if I could get extra features, particularly Dolby 5.1 sound to take advantage of a home theatre scenario. I am more than impressed by the quality of SD pictures and in experiments with a SD/HD box on a quality projector system capable of matching the HD standard of the box, there is little difference to be seen.

Where to now? Senator Alston needs to stop thrashing around and accept the fact that the ABC dropped multi-channelling due to lack of viewers, and allow the commercial stations to multi-channel now; at the very least they could afford to do it. He could also stop protecting the Pay TV operators from competition, which will lead to an improvement in the quality of programming for everyone.

The take-up and disconnection rate for Pay TV shows customer discontent and I can't see more than 10-15% of the population ever embracing the service. PAY-TV has prospered in areas of poor or no FTA reception because there is no competition. These companies have treated their custom-

ers and installers with contempt and do not deserve any protectionist legislation.

The Broadcasters need to give the viewing public at least 5.1 Home Theatre sound on all SD transmissions when the program allows, and keep HD for when the technology becomes affordable. There were times I swear that Channel 7 Digital was transmitting in mono, because my amplifier didn't decode in Pro-Logic.

Digital is a great solution to poor reception areas that currently have or will receive upgraded analog to digital signals. But has the government considered the fringe analog dwellers, who have at best a "fortuitous reception" because they reside in the middle of nowhere. Will they have the gumption to switch of analog signals in 2008 before giving the viewers more choice and viable reasons to change?

Brian Andrews,
Bestek Communications Pty Ltd,
Steels Creek, Vic.

Digital TV has a lot to offer

In reference to the Publisher's Letter appearing the July 2003 issue of SILICON CHIP, I find myself in the strange position of defending digital television. For a person whom is highly critical of the government for not providing the extra funds to allow Fly and Kids to be a success, or allow the commercial networks to multichannel, I strongly feel that digital TV has a lot to offer.

First, let me point out that there are now several standard definition set top boxes available which sell for slightly less than $300. Secondly, there are a number of standard definition wide-screen sets selling for less than $2000 and even a 76cm high definition Samsung wide-screen set appearing with a street value of around $2100.

I am one of the lucky (or foolish) people to spend $3100 on a 76cm Panasonic HD ready set and DGTEC HD STB ($700) and am now enjoying some of the HD broadcasts which are starting to appear. But I would also like to point out that most of the new standard definition programming is now being made in wide-screen, looks fantastic, and requires at least a standard definition box to enjoy in its full glory.

John Serra,
via email.

PIC programmers soon to be a thing of the past?

I just want to raise a point since I haven't seen it mentioned in the pages of SILICON CHIP yet: will PIC programmers (the hardware) be a thing of the past soon? I'm just beginning to get into PICs myself and I've been doing lots of reading about them so far. One thing I'm been trying to decide on is what sort of programmer should I buy/build. There are quite a few of them out there and in the July 2003 issue there is yet another programmer!

Which is all rather confusing for me. More so since I read about how simple it is to program a PIC and it can be done in circuit via a simple ICSP (In-Circuit Serial Programming) cable. This seems the better method to use so after digging around on the net I came across these web sites:

http://www.finitesite.com/d3jsys/16F628.html – "The 16F628: Why the 16F84 is now obsolete."

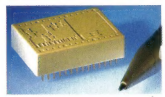
http://people.man.ac.uk/~mbhstdj/piclinks.html – David Tait's web page

Byron A. Jeff's page "Why the 16f84 is now obsolete" is a very interesting read and I thank him for pointing me in the right direction.

David Tait's FPP software package contains a very simple programmer plus schematics for making various interfaces. I made the "TOPIC2" interface and it worked straight away. WOW! I can program PICs! Got a LED to flash on RB0 of a 16F628. But I wasn't fussed on connecting directly to the parallel port as they are notoriously unreliable so I modified the TOPIC2 by adding an old 74LS05 as a buffer. But the 74LS05 is an inverter! No problem. The FPP software has a setup option where you can invert the various signals that it generates or receives which corrects the problem. You can even select which parallel pins are used!

So I'm having fun programming my 16F628 with my home made ICSP cable. I crammed everything into the shell of the D25 plug and terminated the other end with a standard header

The Tiger comes to Australia



The BASIC, Tiny and Economy Tigers are sold in Australia by JED, with W98/NT software and local single board systems.

Tigers are modules running true compiled multitasking BASIC in a 16/32 bit core, with typically 512K bytes of FLASH (program and data) memory and 32/128/512 K bytes of RAM. The **Tiny Tiger** has four, 10 bit analog ins, lots of digital I/O, two UARTs, SPI, I²C, 1-wire, RTC and has low cost W98/NT compile, debug and download software.

JED makes four Australian boards with up to 64 screw-terminal I/O, more UARTs & LCD/keyboard support. See JED's www site for data.

TIG505 Single Board Computer

The TIG505 is an Australian SBC using the TCN1/4 or TCN4/4 Tiger processor with 512K FLASH and 128/512K RAM. It has 50 I/O lines, 2 RS232/485 ports, SPI, RTC, LCD, 4 ADC, 4 (opt.) DAC, and DataFLASH memory expansion. Various Xilinx FPGAs can add 3x 32bit quad shaft encoder, X10 or counter/timer functions. See www site for data.

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This programmer plugs into a PC printer port and reads, writes and edits any 28 or 32-pin PROM. Comes with plug-pack, cable and software. **Also available is a multi-PROM UV eraser with timer, and a 32/32 PLCC converter.**

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that can be used on any future circuits I build. The 74LS05 is powered from the PIC's power supply. The PIC does not have to be disconnected from the rest of the circuit for as soon as the cable is plugged in, it is ready for programming as the /MCLR pin is pulled low. Once programmed, the cable is unplugged and the PIC immediately springs to life.

This is probably all old news to everyone else but I'm just a newbie trying get started somewhere. I don't intend to ever build an all-singing hardware programmer. Can't see the point of it.

David Vieritz,
Mango Hill, Qld.

Comment: you are right of course but there is still a place for PIC programmers.

CD piracy and copyright

The issue of CD piracy and copyright is in the news headlines again. What I can't understand is that one of the biggest whinges is coming from a company that on one hand is in the recording industry and on the other hand manufactures the NET MD which allows the user to connect its Mini Disc recorder to a PC and download up to 320 minutes of MP3 music files that have been sourced from the Internet.

Even their last TV commercial showed a man pulling up in a drive-through in his 'Doof mobile', ordering his favourite music, then off to the collection window where he is handed over a brown paper bag. Out of the bag he removes a mini disc with his ordered music. Nowhere in that commercial was it mentioned the music was royalty-free or that it is illegal to copy music.

I don't have a PC but I can copy audio CDs with my Philips CD audio recorder. It can also be used to create CDs from any audio source; ie, vinyl, cassette, microphone, etc. I can't use normal CD-Rs; they have to be branded CD-R AUDIO. Price wise, in comparison to brand name CD-Rs sold with jewel cases, they cost about 20% more. This is obviously due to the royalty factor that has been included which makes it legal for me to copy my copyrighted audio. I don't mind paying around $1.50 per 80-minute CD, because it is cheap compared to a $4 - $5 chrome cassette.

Like CD-R Audio, royalty fees are also imposed on audio cassettes and on Mini Disc. What annoys me is I can use any of these media to legally copy vinyl, cassettes and CDs that I have purchased, but the recording industry is still getting a cut from the royalties if the media is used for anything other than that; eg, recording a meeting. They can't have it both ways.

Now the industry is playing with the idea of copy protection on CDs. Are they planning on dropping all royalty fees on the recording media?

Simon Kareh,
via email.

Computer power supply cases

Nowadays, many computer system units are being discarded as useless. But one item is quite useful: the power supply case. It is a well-made metal box and, after the PC board is removed, it can be used for many electronic projects. It even has a fixed power plug and a fan, if needed. Don't forget to save the screws and grommets, too.

Jim Jacobs,
Engadine, NSW.

Modern lighting offers plenty of choice

I read the June 2003 editorial and I agree that the currently popular 12V halogen lamps are not very efficient in this day and age. They are still basically an incandescent light source plus the added losses from inefficient transformers. At first glance, they are to many people very appealing and relatively cheap to install – but not necessarily to run. They often present an impressive "showcase" look to a room, hence their popularity. Some lighting consultants will correctly advise that many display homes (featuring halogens) are over-lit. Lots of "attractive spots" with many dark separating patches.

And as for the transformers – efficiency could be a lot better but at a cost. Too many buyers ignore this aspect, choosing only on purchase price, not the true cost-of-ownership price (including running and other consequential costs such as heat removal). There is insufficient awareness hence lack of demand for better products (such as electronic transformers which are at least double the purchase price).

240V halogens are available except only a very limited range. I am not sure about their efficiencies (lumens/watt) but suspect they are significantly less than 12V halogens (offsetting their advantages) as they appear to be running at lower filament temperatures, given the expected manufacturing difficulty of a higher voltage (lighter gauge) filament and its inherent fragility. Another problem is that 240V lamps do not benefit from the current limiting effect of the transformer at start-up. Inrush at start-up presents the highest stresses to a filament from the magnetic forces of the high inrush current (up to more than 10 times the run current).

Despite all the negatives, halogens certainly have their benefits and uses. They are very compact and due to the virtual point-source of the filament, are ideal for efficient beam focusing in a compact housing. They are a very effective choice where spots or focused coverage is required – with very little off-beam wastage (compared to other lamps & luminaires) and offer near-perfect colour rendition (continuous spectrum white light).

They are more efficient than conventional incandescents but nowhere near the efficiency of fluorescents or compact fluorescents (CFLs) in terms of total light output (spherically) from electrical input. Fluorescent light sources are more efficient energy converters but halogens are more efficient optically. And compared with GLS (standard incandescent), halogens are both electrically and optically more efficient. If wide coverage is needed (such as from a bare light bulb) – a CFL is the obvious choice.

It would be a mistake to give the impression that halogens are all bad and waste power. How often have we seen conventional fluorescent fittings or CFLs plugged into inappropriate fittings wasting most of the energy

where a better focused light source is required? The real issue is that we all need to pay more attention to our lighting requirements and appropriately design for each room or application. There is no single universal lamp type, technology or luminaire that is the answer to every location.

We need to consider many factors such as (not necessarily in any priority order) what lighting levels are required over what coverage area, power efficiency, heat output, lamp life/cost, safety, lighting effect, dimmable or not, controls (including timers, sensors, ballasts and transformers), colour rendering and glare control, etc.

The range of CFLs now available at continually falling prices is fantastic. Similarly with halogens, the range is immense (linear, bare lamp & reflector lamps with beam widths of 10 - 60 degrees) benefiting from substantial ongoing development, while the traditional GLS bulb hasn't significantly changed at all in almost 100 years.

New tri-phosphor "T5" fluorescent lamps are raising the bar even higher, especially with electronic ballasts. Their narrower diameter permits smaller housings with superior optical performance. Unfortunately, the technical advice and range of fittings commonly sold through retail lighting shops can be limited. A bit of further research through the vast amount of information available on many lighting industry websites, especially for commercial products, can be most helpful.

I would like to encourage you to consider some articles on lighting and the various technologies to help raise awareness and technical knowledge amongst your technical readership. Your editorial was a great start, hopefully encouraging many readers to give their lighting more thought rather than assuming a few 12V halogen downlights are all that is required.

The key to saving energy is improved design from a better technical understanding of the issues, enabling an informed selection of appropriate lamps and fittings. Any energy saved is money in the bank with reduced greenhouse gases, while improved lighting design will be more comfortable to live or work in.

Murray Nielson,
via email.

Comment: we ran a comprehensive series on electric lighting some years ago.

Switched capacitor fan speed control

The speed control for the ceiling fan, referred to in "Ask Silicon Chip" on page 90 of the September 2003 issue, may be a switched capacitor type, as these are usually encapsulated. They switch one of two capacitors in series with the motor and the third position is a straight-through connection.

The fault may be in the capacitor for the low speed setting but I have found on many occasions the fault lies with the deterioration of the capacitor in the fan itself. This affects the speed of the fan on all settings of the controller but is most noticeable on the slow setting. These capacitors exist in a very hot environment and probably dry out in time.

Barry Hubble,
via email. SC

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The JV80 Speaker System

Design by
PHIL ROUTLEY
Words by
LEO SIMPSON
Assembled by
MICHELLE ONEILE

... all you need is an hour or so and a screwdriver!

The JV80 is a fitting successor to the very popular JV60 system described back in August 1995. The new design uses bigger Vifa woofers (8-inch) and a Vifa D26 ferro-fluid cooled dome tweeter. It is a bass reflex tower design with two ports and it includes overdrive protection.

Over the years, we have published a number of do-it-yourself speakers but the JV60 has easily been the most popular and long-lived.

Now there is this new system, still using Vifa speakers but with bigger (8-inch) woofers and a teensy little Vifa D26 dome tweeter. In fact the tweeter looks so small and insubstantial that you'd wonder how it could possibly stay with the pace set by the two big woofers. Yet it does it easily, due to some fancy technology which we'll get to in a moment.

And while home theatre systems seem to be all the go at the moment, these JV80s are equally suitable for a high-quality stereo system or as the front speakers in a high-quality home theatre system. In fact, the bass response of the JV80s is so good that you can dispense with the subwoofer in a home theatre system.

What's more, we would go so far as to suggest that you dispense with any centre speaker as well. But we're getting way ahead of ourselves . . .

OK, so we're looking at a pair of good-sized tower speakers which stand 950mm tall, 277mm wide and 350mm deep, not including the grille cloth frame. You don't have to make the speaker cabinets though; they are available fully assembled, with the plastic ports, rear terminal panels and some the BAF (bonded acetate fibre) Innerbond lining already installed.

Better still, the cabinet finish is a simulated light timber veneer rather than boring old black. Mind you, the grille cloth is black but that could easily be changed to a scrim (open weave) fabric to match or complement your room decor, if you wish (or your partner dictates!).

The cabinets are made of MDF (medium density fibreboard) and have a volume of about 73 litres (not including internal bracing). The two 66mm flared ports are 140mm long.

Nor do you have to assemble and solder the crossover network. It is supplied hard-wired onto a piece of MDF, ready to be installed into the enclosure.

In essence, what you have to do is to install the crossover network, make the various internal connections and install the speakers. If you are reasonably handy, you could do the whole job in an evening. You will only need a screwdriver to assemble the speakers – not even a

Specifications

Power rating	100W (typical program)
Type	2-way, Bass Reflex with two ports
Impedance	8Ω
Frequency range	30Hz to 20kHz
Crossover	3.5kHz Linkwitz-Riley
Sensitivity	91dB/1W at one metre (on tweeter axis)
Protection	Polyswitch PTC thermistor

The "works", as they come out of the box. There is a pair of crossovers, four Vifa 8-inch woofers, two tiny dome tweeters (also shown enlarged at right) plus two packs of screws and some sealing compound. We suggest throwing the sealing compound away and using draft-excluding foam! Not shown are two large pieces of acoustic wadding.

And here are the boxes, again as they come . . . the boxes are complete, the grilles are fitted, the driver holes are cut out and rebated, the input connector is screwed to the back panel and there is even a layer of acoustic wadding on the back. There's not much more to assembly than fitting the drivers and crossover.

soldering iron is required. In fact, if you have a power screwdriver, so much the better – it is a lot quicker and easier.

Speaker line-up

Two 200mm (8-inch) Vifa P22WP01 4Ω woofers provide the "muscles" in the JV80 enclosures. They are fully characterised with Thiele-Small parameters (Vas 82l, Fs 31Hz & Qts 0.27) and each has a nominal power rating of 100W.

They have a cast magnesium chassis (basket), polycarbonate cones and synthetic rubber roll surrounds.

As already noted, the tweeter is very tiny and seems especially so since it has such a small magnet structure.

But first impressions are deceiving here because the magnet is an alloy of the rare earth Neodymium which means that it can deliver a voice coil flux density equivalent to a much larger conventional ceramic magnet.

In fact, the magnet structure is so small that it has been fitted with a heatsink, to better dissipate the heat produced in the voice coil which is also ferro-fluid cooled. The voice coil diameter of the dome tweeter is 25mm.

In other words, it is a standard 1-inch fabric dome tweeter but until you hear it, you are not going to believe that such a tiny assembly can deliver so much high-quality sound.

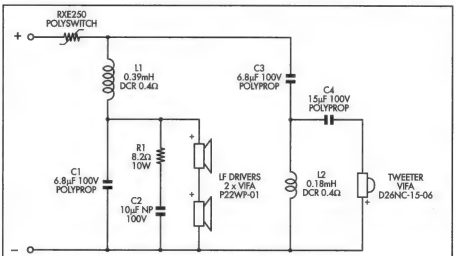
Crossover network

The crossover network is quite complex and provides a third order filter for the tweeter (nominal attenuation slope of 18dB/octave) and a second order filter (12dB/octave) for the woofers which are connected in series, to give a nominal impedance of 8Ω. Crossover frequency is 3.5kHz.

A feature of the woofer attenuation network is impedance equalisation, as provided by R1 and C2.

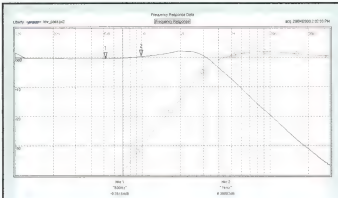
In effect, impedance equalisation cancels out the rising impedance of the woofers, due to their voice coil inductance (3mH), so that the crossover network "sees" a resistive load of close to 8Ω rather than an impedance which rises linearly as the frequency increases.

What happens is that impedance equalisation is a special case of a parallel resonant network which results in a constant resistance, ie, all reactive components due to capacitance

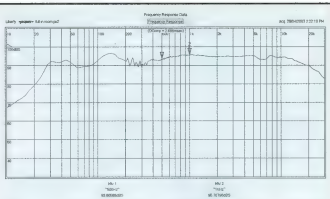


JV-80 LOUDSPEAKER SYSTEM

The crossover network incorporates impedance equalisation for the series-connected woofers. Crossover frequency is 3.5kHz. Note the phase reversal of the tweeter, with respect to the woofers. The Polyswitch PTC thermistor provides protection against over-drive.



These curves show the action of the crossover network in attenuating the signal to the woofers and tweeters. The attenuation slopes are close to 12dB/octave.



The overall frequency response of the JV80s – and as you can see, the bass response is well maintained to below 30Hz. The modest peak at around 150Hz is due to room effects and should be ignored.

or inductance are cancelled out. In this particular case, we have R1 and C2 as one leg of the parallel resonant network and the resistance and voice coil inductance as the other leg.

The resistance of R1, 8.2Ω, in one leg, is close to the total DC resistance of the two Vifa woofers, in the other leg.

While the calculation is not simple, the result is that the capacitive reactance of C2, a 10μF capacitor, cancels out the 3mH inductance of the two woofer voice coils.

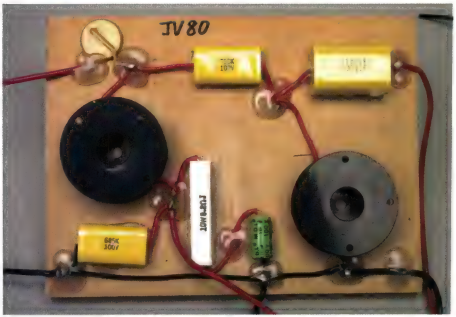
Both the inductors are air-cored, avoiding any distortion effects which result from saturation and other nonlinearities in ferrite or iron-cored inductors. And the crossover capacitors are all high-quality polypropylene types for low distortion.

Before we leave the crossover network, note that the phasing of the tweeter is reversed with respect to the woofers.

This is common in complex crossover networks where the crossover slopes are 12dB/octave or greater and which often have rapid phase rotation in the vicinity of the crossover frequency.

The decision whether or not to reverse the phase of the tweeter (or midrange in a 3-way system) is made on the basis of which results in the smoothest frequency and phase response. So now you know.

Don't forget to make the correct tweeter connection - positive terminal to the negative speaker line.



Here's a close-up of one of the crossovers. Input is on the left, output to the woofers is centre bottom and to the tweeter right bottom. We suggest marking the input and outputs with a felt-tip pen to save any confusion later on.

Over-drive protection

One of the difficulties designers face is setting a nominal power rating for a loudspeaker system. As already noted, the woofers each have a nominal rating of 100W while the tweeter has a nominal rating of 50W.

However, this is a "music program" rating – a pretty vague term. Without any doubt, if you fed a constant tone at 100W into the woofers they would ultimately destroy themselves, while a 50W constant tone to the tweeter would probably burn it out in short order.

In fact, the tweeter has a continuous rating (operating power) of only 5W.

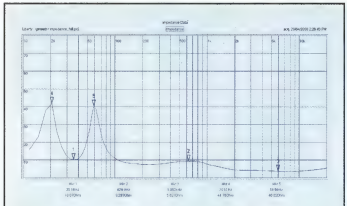
Faced with this dilemma, the designer can only specify a nominal overall power rating for a speaker system and then hope that users will not get over-enthusiastic (or stupid) with the volume control.

After all, a 100W amplifier driven hard into clipping will deliver far more power, perhaps 200W or more, which can easily destroy a 100W speaker.

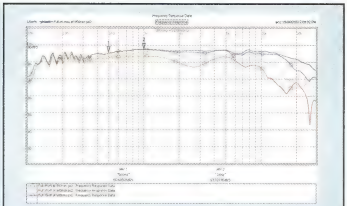
So what to do?

The designer of the JV80 speaker has taken the same approach as in the earlier JV60s; use a PTC (positive temperature coefficient) Polyswitch thermistor in series with the crossover network. Normally, these devices have a very low resistance and thus have a minimal effect on the signal to the drivers.

But when the signal current exceeds a critical (RMS) level, the Polyswitch suddenly goes to a high resistance



This is the impedance curve for the JV80. Notice the double hump at low frequencies which is typical of a bass reflex enclosure. The enclosure is tuned to 35Hz (Mk1). Minimum impedance is 3.62Ω at close to 6kHz (Mk3).



These curves show the "off axis" response of the JV80s and illustrate the good treble dispersion of the Vifa 1-inch dome tweeter.

state and effectively remove the drive signal and thereby protects the speakers from damage.

After a short cool-down period which depends on the initial overload, they revert to their low resistance state and the signal can pass once more.

Listening tests

After we assembled a pair of these speakers (see the step-by-step photos), we had a long listening test with the JV80s, comparing them with a similarly-sized tower system which costs about three times the price.

The results? Surprisingly good.

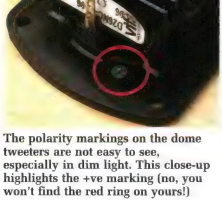
The JV80s have generous power handling and quite good efficiency so they can really deliver a punch. If you have a 50W/channel amplifier, they will be more than adequate in average -sized living rooms. In larger rooms, go for a 100W/channel amplifier.

Overall frequency balance is very good, with smooth extended bass down to below 35Hz (subwoofer territory) while the tweeter is smooth right up to the limits of audibility, although tapering off slightly above 10kHz.

The tweeter has a modest peak at around 5kHz which does give a touch of emphasis to sibilants but also gives a slight prominence to voice and brass. Overall, we think the result is really very good, especially when the cost is factored in.

By the way, for clean, unmuddied bass, the JV80s should be installed at least one metre away from walls and room corners.

Do not place them close to TVs either, as the woofers are not magnetically shielded.



The polarity markings on the dome tweeters are not easy to see, especially in dim light. This close-up highlights the +ve marking (no, you won't find the red ring on yours!)

Step-by-step photos

The photos on the following pages show the procedure for assembling the speakers. In brief, they are:

(1) Drill holes and mount crossover network inside enclosure, adjacent to rear terminals.

(2) Connect two wires to rear terminals (red to positive, black to negative). Mark tweeter (T) and woofer (W) wires on crossover board with black felt-tip pen.

(3) Run sealant around rebated woofer holes. Throw away the sealant supplied in the kit. Use Raven RP14 self-adhesive draft exclusion foam tape instead (available from hardware stores).

(4) Solder push-on connectors onto crossover wires, if these are not supplied already fitted. Do not solder wires directly to tweeter – you run the risk of melting off the lugs.

IMPORTANT: connect the black wire to tweeter positive; the red wire to negative. Install tweeter.

(5) Install roll of Innerbond filler – don't obstruct the port tubes.

(6) Connect red crossover wire to positive terminal of one woofer. Then run another wire from its negative terminal to the positive terminal of the other woofer. Then connect the black crossover wire to the remaining woofer terminal. Install the woofers but only with a couple of screws each.

(7) Do woofer phasing check: connect a 1.5V battery across rear speaker terminals – both woofers should move in or out together.

(8) Fit the remaining screws to woofers – do not over-tighten the screws. If using a power screwdriver, set it to the lowest clutch setting.

(9) Clip on grille clothe frames. Connect amplifier and CD player. Enjoy!

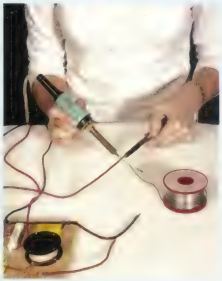
Where from; how much?

The JV80s are available only from Jaycar Electronics stores (and their on-line or mail order "Techstore").

The complete kit – enclosures, speakers, crossovers, ports, terminals, wadding and even the screws – retails for $939 per pair (Cat. AA-0124).

To be frank, we don't think that building your own cabinets will save you a lot of money – but if you must build your own, you can buy the rest of the kit, comprising four woofers, two tweeters, two crossover networks, rear terminal panels, flared ports, sealant and Innerbond, for $589 (Cat. CS-2580).

STEP-BY-STEP: Putting the JV-80s together

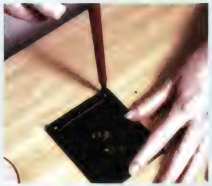


1: We started construction by soldering mini spade connectors onto the appropriate leads. Jaycar have assured us that this will be done already in their kits so you may not have to worry about this step. At this stage, we also made a connecting lead for the two woofers – again, this should be supplied with the kit.

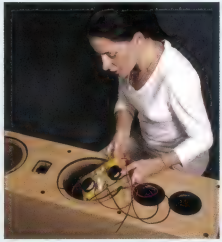
4: Using the holes drilled through the crossovers as templates, drill a couple of smaller, shallow "pilot holes" (about 2mm) in the inside back of the box. Take care that the acoustic wadding doesn't try to wind itself up on the drill bit!

5: Push a couple of the large screws through the holes in the crossovers and locate the pilot holes in the back panels of the boxes. Screw the crossovers down tight – you don't want them rattling around when music is playing!

2: If there aren't already holes in it, drill two mounting holes (say, 3mm) right through the MDF boards which hold the crossovers. Hole position is unimportant but it's probably best to avoid drilling through a component... By the way, mark which pair of wires are which (input, woofers, tweeter) with a felt-tip pen. Saves a lot of confusion later!



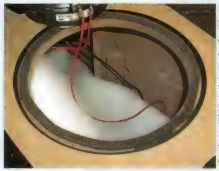
6: Turn the box over and unscrew the input terminal plate. Note how one of the terminals has a red ring and one has a black ring? That fact becomes important in just a moment . . .



3: Feed the crossovers through the centre speaker cutout and place on the inside rear of the box. Each crossover should be situated very close to the hole for the input terminal, with the input leads towards the terminals (the leads are pretty short!).

7: We had to solder the input wires to the crossovers direct to the input terminals. Your crossovers may come with quick-connect spade lugs so that they simply push on. Connect the red input wire to the terminal with the red ring and the black input wire to the terminal with the black ring. Check twice!

8: "Fish out" the red and black cables for the woofers – here's where you'll be thankful you marked which wires were which on the crossover. You'll note we kept them from falling back in by temporarily sticking them to the front of the box with a piece of insulation tape. Tape colour is optional.



12: You'll be much better off using some of this self-adhesive, draft-excluding foam (Raven RP14, which you can buy at any hardware store). This is actually the second box, which we did after having so much trouble with the gunk on the first box!

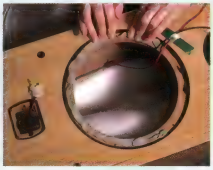
9: Similarly, find the two wires for the tweeter and bring them through the tweeter hole. Another piece of insulation tape will keep them captive. Darn! You can never find a bit when you want it . . .

13: Take the RED woofer wire and push its spade lug onto the "+" (or red) speaker terminal.

10: There are two pieces of acoustic wadding, one for each box. You can feed the wadding through either hole. The idea is to cover as much of the inside of the box as is currently not covered (remember there is one piece supplied already fixed to the back of the box).

14: Attach the woofer connecting wire to the "–" (or black) terminal of the same woofer. Our connecting wire was red, just to confuse you. Let the other end of this wire fall into the hole.

11: Before placing the speakers, you need to ensure no air can escape around them. Some caulking material is supplied with the kit – we tried to use it but found it stuck much better to our fingers than to the wood. Take a tip: dice it.



15: We are about to place the first woofer in its rebated hole. Can you spot our deliberate mistake? Yes, of course the black wire has to be fed through to the OTHER woofer hole. But you knew that already, didn't you?

16: Place the woofer in the hole and carefully push down on the speaker edges until it is seated properly. You could put the screws in now but it's probably best to do it all at once – after a final check!

20: Here's that 'orrible sticky sealing stuff again. You don't need it! We found that the tweeter is such a tight fit in its hole that you don't need anything to seal it. But seeing Michelle had painstakingly posed for this picture we didn't have the heart to leave it out . . .

21: V-e-r-y carefully push the tweeter into its rebated hole. Handle only by the edges and for heaven's sake, don't slip and put your finger through the speaker cone!

17: Next comes the second woofer. The wire from the first woofer connects to the "+" (or red) terminal; the black wire from the crossover connects to the "–" (or black) terminal.

22: Before the final step, let's check the connections. Grab a 1.5V or 9V battery and briefly touch it across the input terminals while you watch the woofer cones. It doesn't matter which way around you connect it – all you are looking for is both woofer cones moving in the same direction. If the cones move in opposite directions, you have reversed the connections to one of the woofers.

18: You know what to do next – you've done this before, haven't you? Watch that cone and edge!

23: Finally, screw in all three speakers. Again, we cannot emphasise how careful you need to be here: one slip and the cone is history.

Once completed, all that's left is to snap the grilles in place, connect the speakers to your amplifier . . . and settle back with your favourite piece of music and beverage, basking in the listening pleasure of your new JV80 speakers (not to mention basking in the glory that will be yours when your friends find out that you built these speakers yourself!). SC

19: Two woofers down, one tweeter to go. Now here's the trap for young players: the RED wire from the crossover connects to the "–" terminal, while the BLACK wire goes (of course) to the "+" terminal. Yes, it sounds wrong – but it's right (check the circuit diagram out if you don't believe us!).

More Hi-Res Digital SLR Cameras –

Canon's 10D and Fuji's S2 Pro

Readers may recall that just one year ago, we looked at the first of the "affordable" DSLRs – the Canon D30, offering six megapixel resolution and an impressive raft of features. Now there are even more contenders for your cash (or plastic!) – and not so much of it, either.

Last year, we were able to get our hands on just one digital SLR (DSLR) camera. We knew that a new Fuji and a new Nikon were just around the corner but Canon came to the party. And we were impressed with their D30. It offered six megapixel resolution and a huge range of user features.

The main drawback, at least as far as we were concerned, was the price: by the time you bought the camera and a couple of lenses, there wouldn't be much change out of ten big ones. That's a pretty serious investment for most people.

Well, things have changed a bit in the last twelve months.

Prices down, features up!

Just as the "happy snap" or point-n-shoot end of the digital camera market has made some pretty amazing moves in the past year (prices plummeting, features and quality soaring) the "pro" end has had its share of movement, too. Maybe not quite with the same ferocity but certainly enough to make us sit up and take notice.

We've been able to test-drive a couple of "prosumer" DSLRs over the past couple of weeks. They're not at the highest end of the pro market, although we understand that plenty of pros are waiting in line. Nor are they the type of camera that Mr or Mrs Citizen would be likely to buy to capture family holidays or baby pictures.

But they are exactly the type of camera that a keen amateur photographer would buy – the type of photographer who probably has a top-of-the-line 35mm camera body or six, a good selection of lenses and possibly even does their own film processing (gad, do people actually still do that?).

And we know from your letters and emails that there are many keen amateur photographers amongst SILICON CHIP readers. Yes, we are predominantly an electronics magazine but our readers have a range of interests!

They are also the type of camera that many professional photographers would buy – particularly news and sports photographers and, say, wedding and PR photographers.

The reason these people would buy one of these cameras can be summed up in one word: convenience.

They also happen to be the type of camera that a photographer for an electronics magazine would buy! We have to be honest: much of the reason for this article has been in the evaluation of high resolution digital cameras suitable for the type of work you see in SILICON CHIP.

But that's getting ahead of ourselves.

The photos in SILICON CHIP

We hope you've noticed that over the last few years, there has been significant improvement in the photographs that appear in SILICON CHIP. Of course, the biggest factor is that they are now all in colour – but comparing them with earlier photos, they are significantly clearer; contrast is better, and so on. We've learned a lot about image processing over the years!

But they are still done the traditional (film) way.

Incidentally, we're often asked why

By Ross Tester

magazines such as ours use positive transparency film rather than (the much cheaper) negative film you'd use for most photography. The reason is that it is usually possible to get a much better result from a positive transparency than a negative. In addition, it's a lot easier to judge the quality of a "trannie" than a negative.

Until now, we have had to buy film (which incidentally is getting very expensive – over ten dollars a roll for the type of transparency film we use). A typical issue of SILICON CHIP might require three, four or five rolls of film. We shoot the vast majority of pics in our own mini studio.

Because the film has to be stored under refrigeration, we have to remember to get the film out several hours before use and let it gradually warm up to room temperature. It sounds silly but that delay can be extremely frustrating.

After the "shoot", we have to get the film developed – also approaching ten dollars a roll. And there's either a courier or someone dropping them in and picking them up – the nearest E-6 (transparency) processing lab is about 30 minutes away.

Then, assuming we have got the pics we want in one take (which fortunately is almost always) we have to select the transparencies we require and scan them using a dedicated film scanner.

We used to send the film away to have this done (adding another three days to the process) but for the past few years have had our own 35mm transparency scanner.

Then it's a matter of processing the image files – sizing, cropping, colour correcting, sharpening, removing dust marks and finally converting them from RGB to CMYK format, ready for placing in the magazine page layout.

We use Adobe Photoshop, which has become pretty much the industry standard.

All this takes time – and with deadlines approaching, that's often time we cannot afford.

The digital way. . .

With a digital camera, almost all of the steps, except the Photoshop treatment, are eliminated. Most importantly, if we want a photo instantly, or if we need a re-shoot, we can have it.

We still shoot much the same way but have the advantage of knowing instantly that we have the shot we want. It is even possible to have the camera "wired in" to a computer in the photo studio so that the pics go immediately onto the network.

Worst-case is that we download them from the camera following the "shoot" using either USB (or the much faster Firewire) immediately after shooting. There is even a RAW plug-in for Photoshop if we want it (although software supplied with the cameras also converts the RAW format).

By the way, to obtain the very best results, a photographer will shoot in RAW format. As its name suggests, this is exactly what the sensor in the camera sees, no processing, no sharpening, no lossy JPG conversion . . . While most DSLR cameras are capable of doing a fairly good job at this, it is basically a "one size fits all" process. Using a RAW image and doing all the processing yourself in Photoshop means you get to choose what you want for that particular shot.

So we can go from shoot straight to Photoshop. (Even well set-up digital photos still need processing). Apart

from the cost of shooting on film and the time taken, it's not easy to see why digital photography is so attractive to publishers.

Multiply that by a few thousand photographers spread over newspapers, magazines, etc – and you're getting some real economies – both in dollars and time.

That's our side of the market. Digitals have become the choice of many other pro and semi-pro photographers for similar reasons. Wedding photographers love 'em!

DSLR vs SLR cost

Quality DSLR cameras cost more – significantly more – than SLR cameras. This has become more so in recent times as SLR cameras have become much cheaper – due, at least in part, to the increasing popularity of digitals.

That's not to say DSLRs haven't come down in price – they have, significantly – but the price of SLRs appears to be dropping faster. The industry now says that digital cameras are well outselling film cameras.

Quality of image

I'm probably going to get hung, drawn and quartered for saying this but in general, the picture quality you get from an SLR camera doesn't have a great deal to do with the camera itself. It's much more about the quality of the lens you hang off the camera.

(OK, the type of film plays a significant role too – but film is an expendable which you can change at will). The camera itself, by and large, does not have a huge influence on picture quality – it just gives you more control, more features.

The results I get from my three trusty (but 40-year-old) Minolta SRT-101s are every bit as good as I have achieved with any 21st century film camera.

But with a DSLR, the quality of the image depends on two factors: the quality of the lens but just as importantly – and often more so – on the quality, or "resolution", of the image-capturing device in the camera.

It is (usually) not possible to get as good a result (even with the same lens) on a camera with a 1 megapixel resolution as it is with a 3 or 6 megapixel resolution. The higher the resolution, the more information the camera captures.

For the average "happy snap" camera user this doesn't really matter. It's amazing what some people will accept when they take the shot themselves because they are remembering what the scene was actually like rather than their blurred photos – we've all seen those proudly-shown-around holiday pics where it's *sometimes* possible to recognise a landmark, or a person, or whatever.

For a pro, poor quality is simply not an option. Either he/she won't get paid for the job, it will have to be done again (if that is possible – eg, weddings!) or he/she will have his/her head bitten off – or worse – by an unhappy boss. Therefore, pros demand high quality. Perfection, even.

Keen amateur photographers are similar. They are not satisfied unless the picture they take is as close to perfect as they can manage. And they are prepared to pay a premium for that, too.

Back to the DSLRs

A few weeks ago I had the opportunity to trial Canon's new 10D. Like the D30, it was a six megapixel CMOS sensor model (actually 6.3 million effective pixels) but Canon have managed to make quite a few improvements in the 10D, which could be regarded as an "economy" model. More on the Canon shortly.

Then the opportunity also arose to play with a Fuji S2 Pro for a couple of weeks. It has the somewhat more traditional CCD sensor (although it is anything but traditional, as we shall see shortly). We still haven't had a chance to play with the Nikon D100 – but it and the Fuji S2-Pro are based on the same platform and take the same (Nikkor mount) lenses.

Super CCD III

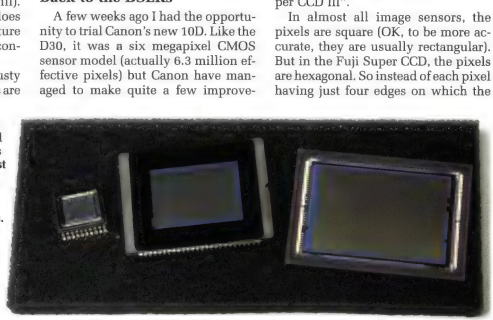
However, there is a major difference between the two – one which has been at least somewhat controversial. Both the Nikon and Fuji have a six megapixel sensor (6.1 million effective for Nikon; 6.17 million for Fuji) – but Fuji claim that their camera gives twelve megapixel results.

Is that possible, or just PR puffery?

It turns out that there is more to it than a copywriter's whim. If you are at all experienced with digital image processing, particularly via software, you would probably be aware of interpolation – where an image size is effectively increased by "manufacturing" image information from the contents of the two pixels adjacent. That's the usual way a picture size is increased from a given file size.

Depending on the algorithms used, such interpolation can be quite good (within reason!). But Fuji's interpolation (they call it processing) is ***very*** good. How? By using what they call a "third generation super CCD" or a "Super CCD III".

In almost all image sensors, the pixels are square (OK, to be more accurate, they are usually rectangular). But in the Fuji Super CCD, the pixels are hexagonal. So instead of each pixel having just four edges on which the



If you've ever wondered why there is such a difference between digital cameras, these three image sensors from Canon might explain why. Just compare the sizes! The one on the left is from a typical "happy snap" (ie, consumer) digital, with a resolution of about two megapixels. The middle one is the one actually used in the 10D and D-30 and is not far off being 35mm film-sized. The huge one on the right is from one of Canon's high-end professional models, with greater than 12 megapixel resolution.

interpolation can work, it has eight edges. Therefore, while the pixels are effectively very similar in size, the captured image contains as much information as if they were half the size (twice the resolution).

That's the good news. The bad news is that at highest resolution you're only going to store one image on a 64MB card. That not only takes time to download, it also takes some time to save inside the camera. At highest resolution, that can be the best part of 20 seconds between shots – an intolerably long time for a sports or news photographer.

Needless to say, you can select the image size you want and so reduce this to much more manageable periods.

Look and feel

There is not too much between the Canon 10D, at 790g, and the Fuji S2 Pro, at 760g. Size is fairly comparable: Canon is 150 x 107 x 75 mm while the Fuji is 142 x 131 x 80 mm. Side-by-side, the Canon appears to be significantly smaller (that 24mm is the big difference).

How a camera feels in your hands is very much a personal thing: I could live with either! The Fuji has been criticised by some as feeling a little bit "plasticy" – after all, it does have a plastic body. Personally, I don't have a problem with that. On the other hand, the Canon 10D has a rubberised grip (metal body), making it at least feel as though you have a better grip on it yourself.

Lenses

Most DSLRs come as a "body kit" – that is, they include things like batteries, cables and software but not lenses. You can easily spend as much money on a lens – and then some – as you can on the camera body. Even semi-pro photographers would need at least two or three lenses as an absolute minimum. Some would need many more!

The Canon 10D takes most of the range of Canon EF lens-mount lenses, while the Fuji takes all of the Nikkor AF-D range, including the latest AF-S type (professional) models.

With lenses, to a large degree, that old adage most certainly applies: "you gets what you pays for". Better lenses cost more dollars.

However, if you are looking to save a few bob, there is a huge range of suitable after-market lenses, many of which give an excellent account of themselves (in fact, the review Fuji had a very nice 24-70 Sigma 1:2.8 on it).

Before we move away from lenses, it's important to note that there is a difference between the focal length of lenses on a DSLR to those on an SLR. To get an idea of the focal length in "35mm" terms, you need to multiply the DSLR lens length by 1.5 – so that Sigma lens I just mentioned would be the equivalent of a 36-105mm lens on a 35mm SLR.

This actually becomes quite important in wide-angle lenses. 28mm or 35mm is considered a good general 35mm SLR wide-angle lens but when used on a DSLR, these become 42mm and 53mm respectively – hardly what you would call wide angle!

Software

Software (or more properly firmware) drives the cameras. That's fixed and to our knowledge, cannot be user-upgraded. As software is being developed and improved all the time, it is quite possible that you might be able to get a manufacturer firmware upgrade in the future.

The other software that you need is that required to first transfer, view and then process in your computer. Both cameras come with a CD full of software offering a variety of functions. And there is a huge range of third-party software and plug-ins for your existing software out there.

Sensitivity

If you're used to film photography, you would be used to film speed or ISO. A low film speed (eg, 25) requires a lot more light to activate the chemicals in the film and record an image than does a high film speed (eg, 400). The trade-off is that, by and large, faster film speeds tend to have more "grain".

Digital photography is no different – except that instead of film, we are talking about the sensor's ability to react to light. The big difference between film and digital is that you can adjust the ISO of the sensor for various light conditions. The Fuji can be set anywhere from ISO 100 to 1600; the Canon from ISO 100 to 3200.

The digital trade-off for these very fast ISOs is not too different to grain in film. In this case it's noise: at the higher levels, noise can become evident in the image, most particularly in the dark sections. It's somewhat akin to "snow" on a TV image.

Reports I have read suggest that the Canon has marginally lower noise than the Fuji at high ISO settings – I could not confirm this.

Storage

Here, I believe, is where the Fuji has an edge over its opposition. It can handle both Compact Flash (Type 1 and II, including Microdrive) and/or SmartMedia (up to 128Mb). The Canon can only handle Compact Flash.

The number of shots you can store depends on two things: the size of the images you want to store and the size of the media you want to store on. Like most in-the-field film photographers who have a few (dozen?) spare rolls of film in the camera case, digital photographers tend to have a few spare media cards – or a notebook computer with a big hard disk to download the day's shoot onto.

Both cameras can also handle an IBM Microdrive (up to 2GB) which can store an awful lot of shots, even at 4MB each!

Changing storage media is only a few seconds' work.

Batteries

The Canon uses a rechargeable Lithium-Ion battery with a CR2025 Lithium battery for date/time backup. Fuji, in their wisdom, have elected for a dual supply system: four AA rechargeable cells to drive the camera proper (NiMH recommended) and two 3V lithium cells to operate the flash.

One big advantage that the Canon has is the option of a separate handgrip – which doubles as a second battery compartment.

The Fuji camera doesn't have this option. But it will operate with dead (or no) lithium cells, albeit without flash, so the fact that it uses readily-available (and cheap!) AAs could get you out of trouble in the wilds of Africa (or a Saturday night wedding, assuming you'd be using external flash).

Lag

In many digital cameras, especially those with auto focus, there is some lag between the time you press the shutter release and the time the shot is actually taken. I have one such digital which takes more than a second – many's the time I have the back of

Fuji's new "consumer" 6MP DSLR

Here's a new digital SLR model recently announced by Fuji Japan/USA that is positioned about half way between the happy snap digitals and the S2 Pro we have looked at in this issue.

The Fuji S7000 sports a similar six megapixel/twelve megapixel image capture of the S2 but has a fixed f2.8-f8 lens.

It can also shoot movies: up to 14 minutes of 340 x 240 pixels using a 512MB xD picture card.

The big news on this one, though, is the price: Hanimex, the Fuji distributors in Australia, have just announced a recommended retail of $1399.00 inc gst. Given the price differentials of other cameras, this compares well with the US price of $US799.00. The S7000 is scheduled for release this month. For more information, visit www.fujifilm.com

someone's head, or someone who has ducked out of shot, etc.

Where a camera has auto focus, some of this time is obviously taken by the auto-focus mechanism doing its thing. But there can be even more delay and it can be really annoying.

With both the Fuji S2 Pro and the Canon 10D there is a small time lag while the auto focus sets but it is usually so short it's hardly noticeable. And the time lag from auto-focus to shooting is virtually non-existent.

The auto focus, by the way, is a dream to use on both cameras. Once the bane of all camera users (film and digital) the auto focus is quick and it is precise. It is multi-zonal with a wide range of options – and if you don't like it, you can always shoot manually.

LCD review

Like most digitals, DSLRs these days have an LCD screen to review your shot.

This is certainly the case with both the Canon and the Fuji – although to my mind the Fuji was better. It's a bit brighter, especially good for outdoor (bright light) shots.

What the LCDs on DSLRs do NOT give you (unlike most happy snaps) is an image preview. This is because the way the DSLR works: it has a flip-up mirror, just like a standard SLR, which is "in the way" of the CCD until you press the shutter release.

The LCD can also give you a lot of information about the shot you have taken (including a histogram); indeed, about all the shots on the storage medium. It is also the display for the various camera user functions.

Getting the pictures out

Taking great pics is one thing – but how do you get them back out again?

There are several ways to do this. You can remove the storage medium and slip it into an adaptor on your PC. You can download them "in situ" via the USB port (or much faster firewire port on the Fuji).

Or in the studio, you can download them "on the fly" to a suitable computer (you're already tethered to a studio flash via a sync cable so it's not a big hardship).

Pricing

Both cameras are fairly similar in price. Both have a recommended retail – the Canon 10D is $3999 and the Fuji S2 Pro around $4200 (though a price reduction was imminent at time of going to press) – and both have a "street price" which can be anything up to several hundred dollars or so less than the rrp.

For instance, we've seen the Canon advertised for as low as $3500. And we've seen it available on-line in Australia for as low as $2455 and the Fuji $2788 (no, that's not US dollars!). Would you want to take the risk and buy on line? Fifteen hundred-ish big ones makes for a lot of to-ing and fro-ing! However, bear in mind that you may run into warranty problems when buying from on-line or overseas.

Buying retail, the price basically depends on how much the seller wants your business and how much they are prepared to sweeten the deal.

OK, which one is best?

Either. Neither. Both. I could not choose between them as far as operability is concerned, nor for image quality. Both achieved superb results, both in our studio and out wandering the streets shooting anything that took my fancy!

I have interspersed a few digital pics in SILICON CHIP over the last month or two and I defy anyone to tell me which ones they were.

The Fuji S2 Pro has the potential for higher quality shots with its superior CCD; to my eyes I couldn't pick any difference, even to the point of enlargement where the pictures began to break up. The Canon 10D, with its CMOS sensor has reportedly lower noise at high ISOs. Again, I couldn't pick it.

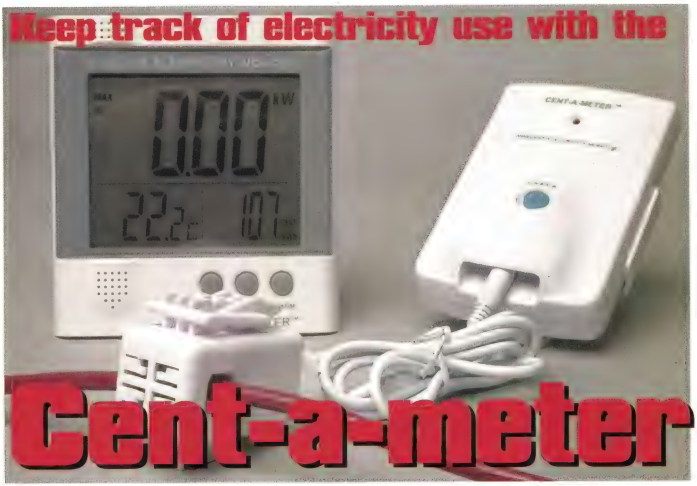
A "pro" friend has a Canon 10D and loves it. I don't know anyone who owns the Fuji S2. And let's not forget that I still haven't played with the Nikon 100D, nor Kodak's 14-megapixel DCS Pro14n, nor several other high-res DSLRs on the market.

To some extent, buying a digital camera of this type would be swayed by (a) personal preferences (like the old Holden/Ford thing); (b) the type of lenses you might already own; and of course (c) what sort of deal you can do.

I don't own any Nikon or Canon lenses (and my [many – sob!] Minolta lenses are too old to cut it on Minolta's digitals), so it's a whole new ball game for me.

I don't have any cross to bear for either Fuji or Canon. . . so I guess it all depends on the dollars.

But one thing's for sure: we're going digital. Will my Minoltas ever forgive me? **SC**



Are you conscious that your electricity bills are higher than you'd like? Would you like to be able to monitor your total household consumption at any time? Now there is an easy way, with the Cent-a-meter Wireless Electricity Monitor.

The Cent-a-meter is a small LCD module which can sit any-where in your home and it can display your instantaneous power consumption in kilowatts (kW), greenhouse gas emissions (kilograms/hour) or cost in cents/hour.

It computes this information from data sent to it by a unit connected to your home's switchboard. The data is sent by an RF link at 433MHz so you can monitor your electricity consumption from anywhere in your home.

And while this is very convenient, it can be quite alarming at times, to see just how much power is being used.

For example, on the first evening after it had been installed, I was surprised to see the power reading in excess of 5kW.

Why? Nothing much was going on, no washing machine, dishwasher or fridge running was running at the time. But what was running was a microwave oven in the kitchen and a 2400W radiator in the family room, plus a few lights, fish-tank and all the gear on standby – nothing much really...

Since then, I have seen much larger readings on that little display and it really does make you conscious of the power being used (and its cost!).

For example, it can draw attention to a radiator or a dryer left running long after it needs to. Or lights running in rooms where no-one is present...

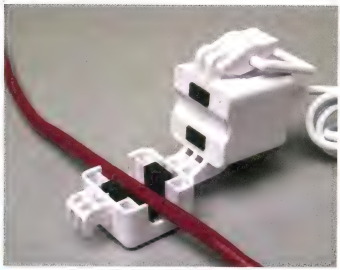
And it can make you very conscious of just how much standby power you are using when nothing at all is being used, supposedly. All that electronic gear with remote controls really can cost you quite a lot of money to run over the course of a year.

How it works

A current transformer is clipped over the main supply lead in your switchboard (there is no actual electrical connection).

This transformer is connected to a 433MHz transmitter module mounted just outside the switchboard. It digitises

Review by LEO SIMPSON



The current transformer, shown *in-situ* at left and opened-out ready for installation above, simply clips over the Active mains wire feeding the main supply meter and/or main switch. While no connection is made to any live wires, the fact that the switchboard needs to be opened up means that a licenced electrican should install the current meter. Care must be taken that the thin cable to the transmitter is not severed or shorted by the fuse box door when closed. Because off-peak hot water operates under a different (usually much lower) tariff, this is not normally measured (however, you could have the Cent-a-meter across the off-peak hot water service only and enter its tariff to find out what that costs you.

the reading from the current transformer and sends it as a serial data burst once every six seconds to the LCD receiver module in your house.

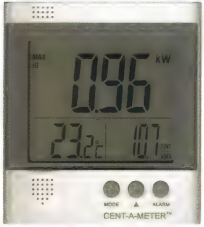
The LCD module then computes the power consumption and displays it as noted above. Note that only the 240VAC supply current is monitored, not the voltage, so the displayed power is computed with an assumed input voltage. This may be set to 110V, 220V, 230V, 240V or 250V.

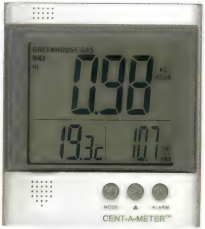
For example, in my home the mains voltage seems to sit at between 245 and 250VAC so it would be appropriate to set the unit at 250V. The factory (default) setting is 240V.

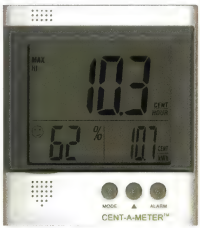
Also note that since the Cent-a-meter does not monitor voltage, it makes no allowance for distortion in the 50Hz mains supply waveform or power factor of the load. It just calculates the product of the measured current with the selected voltage (eg, 240V) and displays the result as power. However, we have been informed by the designer that the current measurement is a true RMS value.

The display resolution is .01kW (ie, 10W) and overall accuracy is largely dependent on that of the current transformer.

This is specified as <5% for currents between 3A and 71A, <10% for currents between 1A and 3A and not specified for currents below 1A. Nevertheless, the Cent-a-







The three measurement options for the Cent-a-meter: at left, it is showing the power being consumed at that instant (incidentally, by a 1kW electric radiator). In the middle is the amount of greenhouse gas that power useage generates. Finally, at right, the most important figure of the lot – what that power is costing per hour. We used a tarrif of 10.7c/kWh, as shown bottom right. This has recently increased slightly.

meter is a very useful indicator of instantaneous power demand.

To display the electricity cost per hour, a fixed tariff is assumed and again, the factory default setting is 12c per kilowatt-hour.

This can be set to your local tariff which for Sydney is presently between 10.95c and 11.35c/kWh (including GST), about the cheapest in Australia. Some other states are much higher, with Adelaide, South Australia, paying as much as 18.88c/kWh.

Whether you use the factory default tariff or your local tariff, the Cent-a-meter ignores the lower tariff for the first 1750kWh block (or whatever the level is). It does not need this information because it only displays the present cost of electricity being used; it does not make a calculation for power used to date.

Greenhouse gases

As already noted, the Cent-a-meter can display greenhouse gas emissions for your current level of power usage. This is assumed to be 1kg of greenhouse gases (CO_2 etc) per kilowatt-hour. However, as with the other defaults, you can plug in other values, if required.

The LCD module also alternately displays the room temperature and relative humidity and continuously displays the electricity tariff.

Monitoring 3-phase power

Most home installations will be single-phase and even then they probably won't be set up to monitor off-peak hot-water electricity consumption since that is normally a much lower tariff.

But what if your home uses a 3-phase instantaneous hot-water heater or perhaps a big air-conditioning system?

In that case, the Cent-a-meter needs to monitor the current in all three phases and that means extra current transformers are required. The transmitter module has provision for three current transformer inputs for this very reason.

By the way, the transmitter module runs from two AA alkaline cells and these are expected to last about 12 months.

Three AA cells are used in the LCD module and interestingly, their life can be extended by changing the update rate from once every six seconds to once a minute. Presumably the saving comes about because the internal microcontroller stays "asleep" for longer periods.

Range of the transmitter module is stated to be up to 30 metres in the open. Certainly there was no problem with range in my own largish 3-storey home so there should not be any problems in this regard.

Overall, the Cent-a-meter is a very well conceived product. Designed in Australia, with patent pending, it is likely to be very popular both here and overseas.

It retails for $149 including GST. Installation cost is extra, with the company recommending that a licenced electrician do the job.

We expect that Cent-a-meter will be widely available from electrical wholesalers and hardware stores. It is presently available from AGL Energy shops.

It is distributed throughout Australia by Gerard Industries Pty Ltd (Clipsal). Further information is available at **www.clipsal.com.au** and **www.centameter.com.au** SC

www.siliconchip.com.au

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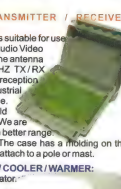
(NEW) 2.4GHz STEREO AUDIO VIDEO TRANSMITTER / RECEIVER KIT:
(10mW Maximum legal power). These high quality units are complete but require some soldering to connect the dc input and the antenna. A simple 1/4 wave antenna can be made from a 31.25mm wire but it will give very limited range as the transmitter has an output of less than 10mW. A much better option is our 1/4 wave Bow-tie antenna kit (SEE BELOW). A short length co-ax is supplied as part of the video TX / RX kit to connect to the antenna. Simply make the connections to the power,

antenna and connect the audio and video from your camera, TV or video via the RCA connectors supplied on each of the circuit boards. Other features include On/Off switches and 4 switchable channels with indicator LEDs (up to four of these units can be used in the same place without problems). Transmitter: 80 (W) x 87 (L) x 22 (H) mm. Receiver: 110 (W) x 90 (L) x 18 (H) mm. PRICE: (K199) $59 Inc. TX and RX Transmitter: 9V DC plugpack. $5. Receiver: 12V DC plugpack. $5

(NEW) 2.4GHz TRANSMITTER / RECEIVER ANTENNA KIT: (K199)
This bow-tie antenna kit is suitable for use with our 10mW 2.4GHz Audio Video Transmitter / Receiver. The antenna was tested with our 2.4GHZ TX / RX kit and gave good quality reception at just over 100M in a industrial estate just over 100M wide. This was as far as we could easily test the units over. We are confident that it has much better range



KIT: $7. Case included. The case has a molding on the rear that makes it easy to attach to a pole or mast.

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Convenient mini Refrigerator. Uses a thermoelectric Peltier device. This great mini-cooler is perfect for a few cans of drinks (it will hold up to 6 std. 375ml cans), ideal for picnics & professional drivers etc.. Operates at 12V DC (cigarette lighter plug) or 240V AC (mains adaptor not supplied). Includes removable shelf, cigarette lighter plug & owners manual. Capacity; 4L. Cooling Capacity: 20 deg. Celsius below ambient. Heating capacity: 65 degrees Celsius. Internal Size: 210 (H) x 140 (W) x 130 (D) mm. External Size: 280 (H) x 190 (W) x 260 (D) mm. Weight 3.4kg. $59

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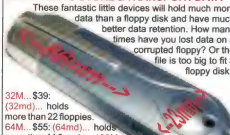

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(ELN5B) Blue 5mm , Water Clear Lens (If = 20mA MAX, Vf = 3.6V) : $1.50 each

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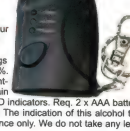
(ELN5R) Red 5mm Water Clear Lens (If = 20mA MAX, Vf = 2V): $0.60 each



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Now you can carry your own personal alcohol breath tester in your pocket. Gives readings of >0.02% and >0.05%. Features: Small & light-weight (40g), Key chain & Torch function, LED indicators. Req. 2 x AAA battery, not supplied. NOTE: The indication of this alcohol test gives BAC for reference only. We do not take any legal responsibility. $27

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Upgrade to a 4W panel for just $25 more..$124

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PUMP2 (NEW) FOUNTAIN PUMP 12V DC 5W:
Special Submersible Pump for Aquarium, Fountain and Garden. Pumps a Head of up to 70cm (H) at 400L p/h. Voltage: 12V. Wattage: 5W. Supplied with 12V AC pluppack and owners manual. Approvals: GS, CE, UL, CUL, SAA, BSI. (Available late July)$16

PUMP3 (NEW) 60W FOUNTAIN / POND PUMP:
Special Submersible Pump for Aquarium, Fountain and Garden. Pumps a Head of up to 350cm (H) at 3000L p/h. Voltage: 240V. Wattage: 60W. Operate at mains 240VAC supply. (Available late July)$36

PUMP4 (NEW) 150W FOUNTAIN / POND PUMP:
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SC_OCT_03

A dirt cheap, high current bench supply

Got an old PC gathering dust somewhere? It mightn't be much good these days but its power supply could be . . . especially if you want a high current bench 13.5V supply! This article tells you how to modify one – at very little cost!

WARNING

This is NOT a project for the inexperienced. Much of the Switch Mode Power Supply circuitry is at full mains potential and contact with it can kill you. NEVER open up an SMPS case when it is connected to power, even if turned off. Beware of any residual charge on the mains capacitors, even if turned off for some time. DO NOT attempt to modify a SMPS unless you are fully competent and confident to do so.

The concept of converting a disused computer power supply to 13.5V operation was first mooted in the November & December 1998 issues of the no-longer-published "Radio and Communications" magazine. This article builds on that information.

The process is relatively straightforward and involves removing all the components involved with the existing 5V and 12V outputs, rewinding the main transformer and then changing the feedback components to give an output of 13.5V instead of 5V.

First, a few words on selecting the power supply to be modified.

It must not be an ATX type since they work quite differently to the types under discussion in this article. Then check that it will maintain a constant output voltage under load, eg, one or two 12V 50W halogen lamps.

Reverse engineering and conversion to a new output is difficult at the

One of the nice things about using an old PC power supply is that it already comes in its own high quality case, complete with fan. Some even include the mains switch – though none will have the large binding post terminals! This is a typical XT/AT-type supply, around 230 watts (and therefore capable of 13.5V @ 17A). You *often* find these PCs junked in council cleanups, etc.

By Col Hodgson

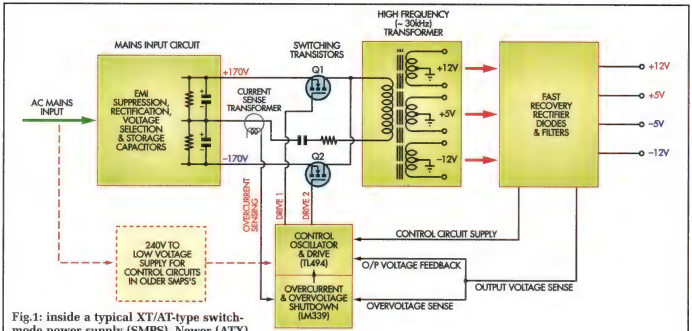


Fig.1: inside a typical XT/AT-type switch-mode power supply (SMPS). Newer (ATX) supplies work a little differently.

best of times and nigh on impossible if the thing does not work in the first place!

Second, consider your power requirements. If you only need about 10A at 13.5V, you probably don't need to change the main transformer as the original +12V can be modified to deliver 13.5V. This means that only the output voltage control sense circuits need changing.

Third, choose a unit that contains the least amount of dust (possibly had the least use!) and check the fan for free movement and lack of "end play" in the bearings.

Fourth, check if the unit uses two ICs in the control circuit: a TL494 and a LM339. Their IC pins and functions are easily identified, making analysis of the circuit much easier. If you can't identify the ICs, you may still be able to modify the supply, but you will be you will be very much on your own and the information in this article may not be of much help.

What is involved?

The main transformer will have to be removed, rewound and replaced. Minor modifications are made to the mains circuitry.

The +5V, +12V, -12V and -5V output components are removed, with the exception of the +5V rectifying diodes and transient suppression network. A new +12V output filtering circuit is installed.

The output voltage sensing resistors will need to be replaced. Jumper wires will need to be placed to supply the control circuit and the fan.

Before we get too involved, some theory of operation is required.

Principles of PC power supply operation

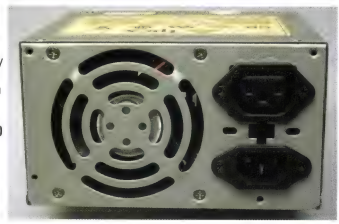
The basic principles of typical PC power supplies can be described with reference to the block diagram of Fig.1.

(1) The 240VAC mains input circuit contains the usual suppression components of chokes and capacitors before the four normal rectifier diodes in a bridge configuration. The rectified mains then passes to two storage capacitors connected in series. These capacitors will charge up to about 170V each and may be subject to ripple currents up to 5A or more.

(2) Transistors Q1 & Q2 are alternately switched at 30kHz or more to provide a high frequency alternating current to the main transformer primary. A small transformer with a single-turn primary winding senses the level of input current in the common line to the main transformer.

(3) The main transformer has three secondary windings providing the high current +5V and +12V outputs and a low current -12V output.

(4) Large, fast-recovery double diodes (with a common cathode connection) in plastic TO-220 (or similar) packages rectify the high current +5V and +12V outputs while smaller, fast recovery diodes rectify the -12V output. The -5V line is derived via a 7905 regulator from the -12V output. A



The only way you can tell from this angle that this is the modified supply is the absence of a 110/230V switch. This is removed because (a) it is quite superfluous here in Australia/NZ and (b) because over the years we have seen too many people flick switches like this with (briefly) spectacular results.

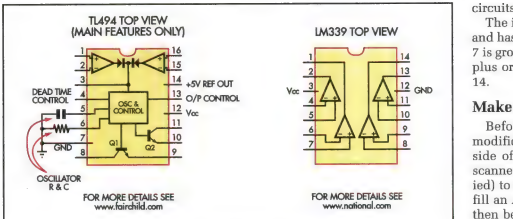


Fig.2: the two main chips you'll find inside a typical SMPS are the TL494 and LM339. Here's the pinout (and functionality) of both.

large, multi-winding toroid provides initial filtering for the several outputs. Final filtering is provided by electrolytic capacitors and smaller inductors.

(5) The main component in the control circuit is a TL494, Samsung KA7500B or equivalent IC. An RC network controls the operating frequency of the IC. The alternating drive to the switching transistors is pulse width modulated, depending on the load current demand, higher currents being supplied by longer duration pulses up to a maximum duty cycle of 45%.

The output voltage feedback controls modulation width.

The LM339 and/or discrete transistors senses over-current or over-voltage output conditions and shuts down the TL494.

Features of the TL494

This is only a brief description of the operation of this IC. Further information is available from **www.fairchildsemi.com**

The IC contains an oscillator capable of operating between 1kHz and 300kHz. The frequency is controlled by an RC network on pins 5 (c) and 6 (r).

Two error amplifiers are included: pin 1 (non-inverting) and pin 2 (inverting) for amplifier 1 while pin 16 (non-inverting) and pin 15 (inverting) are connected to amplifier 2. The outputs from these amplifiers are commoned and internally control the pulse width modulation section of the IC. The common output is also connected to pin 3 to provide external control over the pulse width modulation.

There are two output transistors with open collectors and emitters: Transistor 1 has pin 8 (C1) and pin 9 (E1) while transistor 2 has pin 11 (C2) and pin 10 (E2). These transistors can handle up to 200mA.

The Dead Time control (pin 4) limits the duty cycle for each transistor to a maximum of 45% (0V to pin 4). This provides a 5% protection interval, preventing both output transistors being on at the same time. The Dead Time control is also used to disable the chip if an over-voltage or over-current condition occurs. Pin 13 (output control) may be used in some circuits to disable the TL494.

The input supply (Vcc) is to pin 12 and has a maximum value of 42V. Pin 7 is ground. A reference voltage of 5V plus or minus 5% is available at pin 14.

Make a drawing

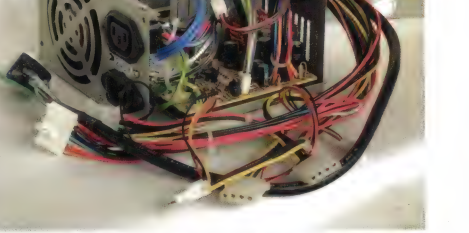
Before commencing testing and modification, I suggest that the underside of the PC board (track side) be scanned and printed (or photocopied) to produce a grey scale image to fill an A4 page. The components can then be drawn on the page in a contrasting colour (red?) to assist tracing and identifying the various circuit features.

By the way, if you haven't already got the message, modifying one of these power supplies is not a quick or simple job but it does have the big advantage that you get a large output DC supply for very little cost.

Pre-test before modification

Some more recent PC power supplies derive their control circuit power from the +12V output. This feature allows the control circuit of these supplies to be powered and checked without connection to the 240VAC mains.

Connect a 33Ω 5W resistor between the +5V output (red) and ground (black) and a 47Ω 5W resistor between



Here's what you should find when you lift the lid on the switch-mode power supply. Usually it's only four or so screws to get this far. All of the external cabling will be removed. Never run the supply with the lid removed unless testing – and then only with extreme care. These things can be lethal!

the +12V output (yellow) and the +5V output (red). This will maintain an approximate 5V to 12V ratio between the respective outputs.

A variable DC power supply (8 to 14V range) is connected across the +12V output and ground. Check for power at pin 12 of TL494. It should be almost 0.6V less than the supplied voltage.

In the absence of power, a jumper needs to be placed between pin 12 and the +12V line.

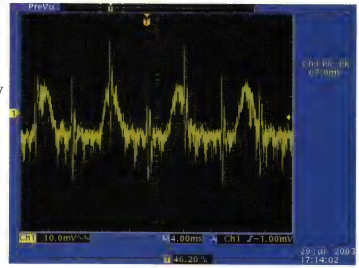
An oscilloscope is used to view the waveforms and operation of the TL494 and LM339 as the applied voltage is slowly raised from 8V to 14V (no higher than 14V). A 30kHz (or higher) sawtooth waveform should be present at pin 5 and square waves should be visible on the ungrounded output pins 8 and 11 (or pins 9 & 10).

These oscillations should stop as the voltage is raised to the level equivalent to the design output. The waveforms should reappear as the voltage is reduced. If the over-voltage circuit has been activated, the waveforms will not reappear until the circuit is reset by removing the power.

Careful adjustment of the power supply is necessary to demonstrate these two very similar voltage levels.

If no oscillations are observed, pin 4 of the TL494 will need to be isolated from the circuit and connected directly to ground (follow the track from pin 4, desolder and lift one leg of each component connected to this track, the track can then be grounded by a jumper wire). The over-voltage protection circuit will now be inoperative.

Re-connect the power and a sawtooth waveform should now be visible at pin 5 and square waveforms at pins 8 & 11 (or pins 9 & 10). Do not exceed 14V in an attempt to demonstrate the over-voltage protection mode – you have just disabled this circuit!



This waveform shows the ripple and noise output of the modified power supply. While it looks horrible it is only 67mV pk-pk. Note: measuring this waveform should be done on the external outputs, not inside the power supply (for safety's sake!).

Use a multimeter to measure the reference voltage at pin 14; this should remain constant at about 5V, as the supply is varied. Make a note of this reference voltage.

Next, measure the voltages at the input pins to the error amplifiers, pins 1 & 2 and 15 & 16, as the supply voltage is varied. Note: one of these amplifiers may not be used in the circuit. The pin with the constant voltage, pin 2 or 15 (inverting input) is connected to pin 14 via a resistor or a potential divider network and serves as the reference voltage for the error amplifier. Make a note of this voltage too.

The non-inverting input, pin 1 or 16 is connected to the +12 and +5V outputs via another potential divider network to sense the output voltage. You will need to trace the connections to this pin to identify the voltage feedback network.

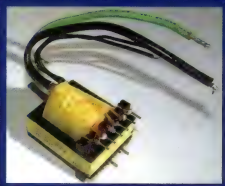
The signal from the TL494 to the driver transformer can also be checked. The primary of this transformer is a centre-tapped winding with the centre pin grounded. The signal to the other two pins should be identical in shape and amplitude (sketch these waveforms).

A dual trace oscilloscope will show the phase relationship between these waveforms (no overlap at all). The waveforms at the five output pins of this transformer will vary as the circuitry to the "chopper" transistors is not symmetrical, however the waveforms should be roughly similar.

Voltage measurements also need to be made at the input pins of the comparators in the LM339 IC. Usually only two comparators are used; the remaining inputs are tied to ground or Vcc.

Two pins (the inverting inputs) should maintain a fixed voltage equal to the reference voltage on the input to the error amplifier on TL494.

The pin with the varying voltage (a non-inverting input) is connected to the supply output by a voltage divider network and senses an over-voltage condition. This part of the circuit will



The original transformer, as removed from the PC board.

It's dunked in paint stripper overnight . . .

. . . allowing fairly easy disassembly. Make sure the ferrites and bobbin are very clean before going any further. Don't worry about the wire – you won't be using any of that.

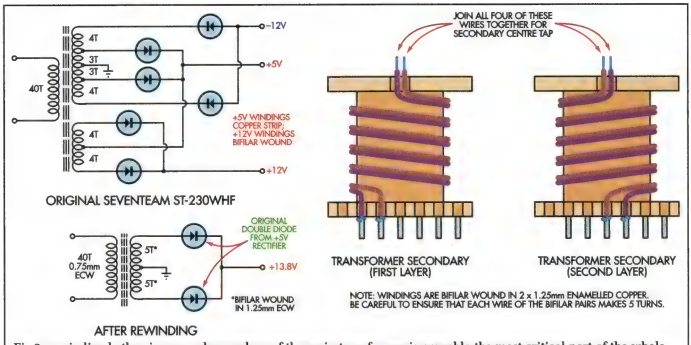


Fig.3: rewinding both primary and secondary of the main transformer is arguably the most critical part of the whole exercise. The primary is rewound because its insulation will probably have been destroyed by paint thinners.

also need to be identified and modified.

The other non-inverting input pin is connected to the over-current protection circuit. This portion of the circuit does not require modification as the over-current condition is detected at the input to the main transformer.

Take careful note of the results from the above testing procedure. The test will need to be repeated after the modifications and transformer rewind as a final check before the ultimate check, applying mains power. The only difference is that then there will be no output to the original +12V, the new output appearing at the original +5V output.

If your PC power supply cannot be tested with an external DC supply, you can still modify it but it will be far more difficult (and dangerous) to do any initial testing. However, you can still trace out the circuit and then follow the procedure within this article to make the necessary modifications.

WARNING

The internal wiring of switch-mode computer power supplies is dangerous when powered up. Not only do you have bare 240VAC wiring to the IEC sockets but a good portion of the circuitry is +340V DC floating at half the mains voltage. It is POTENTIALLY LETHAL!

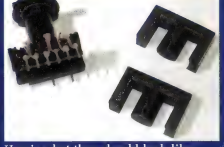
Use extreme care if you do decide to take measurements on the supply when the case is open and DO NOT TOUCH ANY PART OF THE CIRCUIT when it is operating. Make sure that it has been disconnected from the mains for about 15 minutes making any modifications.

Transformer rewind

The transformer operates at a frequency of between 30kHz and 85kHz and consequently is much smaller, with a surprisingly small number of turns, compared to an equivalent mains transformer operating at 50Hz.

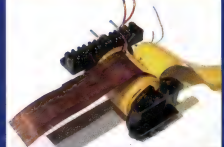
Begin by unsoldering and removing the main transformer. Then submerge it in a container of ordinary paint stripper overnight, before any attempt is made at disassembly.

NOTE: Paint stripper is highly caustic and care should be exercised during this operation; use gloves and eye protection!

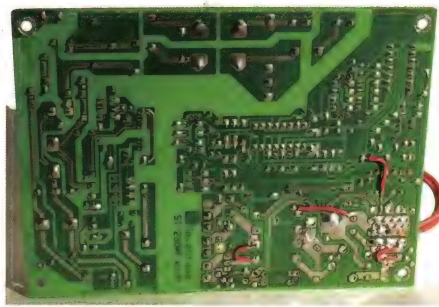


Here's what they should look like after disassembly. The next step is to wind on a new primary, as shown at right . . .

Make sure it is a tight, neat winding – otherwise you might run into space problems.



The original inter-winding shield is re-used. Note the layer of insulation between the windings.



There are a few modifications that you need to make to the PC board. These will vary according to manufacturer so be careful as you trace the circuit out.

The next day, carefully wash all traces of paint stripper from the transformer. The ferrite cores should now slip easily out of the bobbin. Keep careful WRITTEN notes of the windings (number of turns and pin connections on the bobbin) as the transformer is disassembled. In particular note the primary pin connected to the interwinding shield, if fitted.

ALL windings have to be removed as the primary has also been subjected to the effects of paint stripper.

The ferrite core halves and bobbin should be thoroughly cleaned of all traces of adhesive, potting residue and paint stripper before rewinding. This may involve another overnight soak in paint stripper. Surprisingly, the paint stripper appears to have no effect on the bobbin.

Care must be exercised during rewinding due to the space limitations imposed by the ferrites. All windings must be tightly and closely spaced. Do not overdo the application of insulation tape nor use larger gauge wire than suggested.

Editor's note: we recommend the use of a polyester tape when rewinding the transformer, to ensure adequate high voltage and high temperature ratings. A suitable tape would be Farnell Cat 753-002 (19mm) or 753-014 (25mm).

Rewinding the primary

Rewind the primary with the same gauge wire and the same number of turns as initially used (usually 40 turns of 0.8mm enamelled copper). If the primary has been split into two windings (inside and outside the secondary windings) it should be replaced with a single winding.

The primary is usually wound as two layers of 20 turns each. A single turn plus 10mm overlap of insulating tape is placed between the two layers during the rewind. The overlap must be located on a face of the bobbin not covered by the ferrite cores (see photo).

Another single turn plus 10mm overlap of polyester tape is applied over the final primary layer and the interwinding shield is then replaced.

NOTE: this shield is approximately one turn and must be insulated so it does not form a single shorted turn.

Terminate the primary winding and shield to the appropriate pins (in accordance with your written notes!) and cover with two layers of insulating tape (trim to exactly two turns, no overlap).

Thin strips of tape are used to build up the end spaces of the primary so the above tape layer forms a uniform cylinder the full length of the bobbin.

Insulation at margins

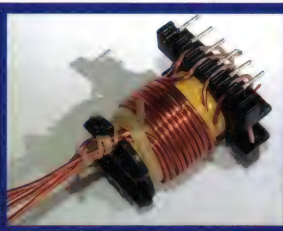
After each primary layer is wound, install lengths of PTFE sleeving over the wire ends before terminating them at the bobbin pins.

The idea here is to ensure that all possible points of contact between the primary and secondary windings are doubly insulated.

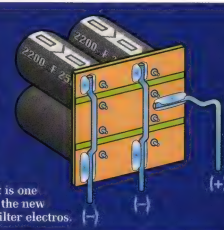
Suitable PTFE sleeving is available from Farnell, cat 583-935 (0.86mm bore; other sizes are available).

After terminating the primary windings and shield to the appropriate pins, use strips of insulation tape (trimmed to the appropriate width) to build up the gaps between the ends of the windings and the bobbin shoulders.

Once you have a uniform cylinder, cover the entire winding (right up to the bobbin shoulders) with exactly



Then on go the secondaries again, nice and tight. The rubber bands are removed before adding the final layer of tape. Fit PTFE sleeving over the wire ends so that no part of them will be exposed once the primary-to-secondary insulation tape is applied. You may be able to re-use the original tubing if it is undamaged.



At right is one idea for the new output filter electros.

two turns of insulation tape (no overlap).

Wind the secondary

A total of ten turns, double wound and centre tapped of 1.25mm enamelled wire forms the secondary. This winding is rather difficult to apply because the larger gauge wire has a tendency to spring open. Use a rubber band as a temporary hold after completing each winding.

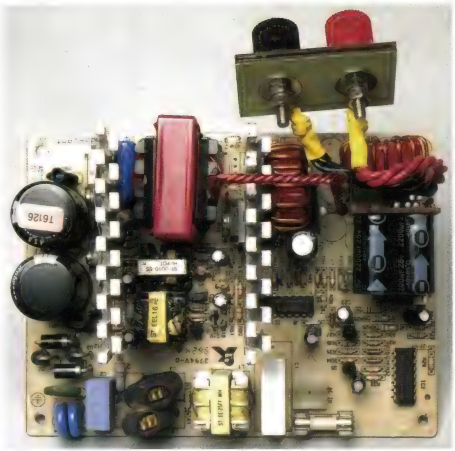
Start by selecting one of the outside four pins used to terminate the original 5V winding (largest gauge wire). Wind on five turns, tight and closely spaced, in the direction away from the other three pins, bringing the end of the wire up through the notch in the bobbin top. Leave about 20cm of free wire.

Select the adjacent pin and wind another five turns in the same direction and placed between the turns of the first winding. Allow the first coil to expand lengthwise along the bobbin as needed. Terminate this winding as above.

Check and recheck that you have exactly five turns on each winding, otherwise you will effectively have a shorted turn. Firmly cover this layer with one turn plus 10mm overlap of insulating tape.

The second layer begins from the outer pin of the remaining 5V pins. Wind five closely spaced turns in the opposite direction to the first layer and terminate through the top of the bobbin. Again, leave 20cm free. Starting from the remaining 5V pin, wind another five turns placed between the turns of this second layer. Terminate as above.

Again, check and recheck for exactly five turns on each winding. Firmly cover this final double winding with two layers of tape.



Apart from the obvious output terminals, the changes made to the original supply are not all that obvious in this modified one.

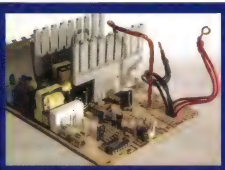
Refitting the ferrite core

This is the real test of the rewind. Carefully cautiously slide the ferrite core halves into the bobbin; remember, they are very brittle!

If you are lucky and have been very careful, they may slip into the bobbin without any obstruction. If not, remove one turn of the outer tape layer and try again.

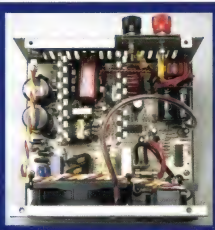
If you are still unsuccessful, it may be possible to gently squeeze the windings in a vyce, padded with two pieces of wood, to press the secondary into a slight oval shape. No vyce? Place the bobbin between two pieces of wood and GENTLY tap with a hammer. If the ferrites will still not fit, the secondary will have to be rewound

Once the ferrite core halves have been fitted, with no spacing or foreign matter between the joining faces, two layers of tightly stretched tape will hold them together.



Here's the stripped PC board with rewound mains transformer in place, ready for the new output filter components.

Add a pair of polarised terminals on their own mounting plate and fasten it to the power supply case, as shown at right.



Modified, checked, tested, reassembled . . . ready for the lid to go back on. And at the risk of sounding boring, for your own safety don't apply power while the supply is in this condition.

Start across the base with the first length gently stretched, then tightly stretch the tape after the first corner. Finish with a gently stretched length across the base.

Final assembly

Gently twist the four 20cm centre-tap leads into a rope formation. Scrape the enamel off all wires and gently hook around their corresponding terminations pins and solder. Take care, the pins can be broken out very easily, particularly the pins for the secondary terminations.

Replace the transformer in the board and bend the flying lead centre tap to its connection point (on the board: This hole may need to enlarged slightly. Trim, clean and tin the end of this lead.

PC board modifications

After identifying the critical circuit features and rewinding the transformer, the PC board modifications are almost an anticlimax. The first modifications are to the mains circuit.

Remove, by desoldering or cutting, the input voltage selector from the board. Note: in the 230V position this switch is OPEN.

Three mains-rated 10nF capacitors (X2 class) are connected across the back of the IEC socket to reduce rectifier noise imposed on the 240VAC mains. The capacitors are connected between Active & Neutral, Active & Earth and Neutral & Earth.

Now we come to the output circuit. Do not remove the lower (earthed) output voltage sensing resistors. Starting from the output leads, work back to the transformer and remove all -5V and -12V components, including the spike suppression resistor-capacitor combination across the -12V winding.

Repeat the procedure for the +12V components, include removing the double fast-recovery diode from the heatsink. Remove all +5V components back, to the fast-recovery double diode. Leave the diode and the spike suppression components in place.

The multiple winding toroidal choke is also removed, stripped of its windings and then rewound with 14 turns of 1.25mm enamelled copper (ie, a single winding). You will need two chokes of 14 turns each in the filter circuit.

The new +13.5V output filter is a low pass "T" configuration with the two rewound chokes and four 2200uF 25V electrolytic capacitors. Using the original +5V output copper tracks, insert and solder the new filter toroid.

The placement of the remaining filter components will depend on the physical layout of the original +5V output tracks.

I used a small piece of PC board to hold the four 2200µF capacitors. This board was then mounted off the SMPS board using some spare 1.25mm wire. (Editor's note: we strongly suggest that the four 2200µF 25V electrolytics should be low ESR types, such as those available from Altronics in Perth; cat R-6204).

The second toroid was soldered to the +5V output pad and to the first toroid. A ceramic disk capacitor (100nF [0.1µF] 63V) was added to the SMPS circuit board in parallel with the four 2200µF electrolytics.

Jumper wires between the following points are needed to complete the circuit:

(1) The common cathode of the fast recovery diodes to the supply circuit for the TL494 IC;

(2) The final output pad to the fan; a resistor may be used for this jumper to reduce fan speed and noise.

The values for the voltage and over-voltage sensing resistors need to be calculated. Replace the original resistors with these new values.

In practice, you can leave one of the resistors in place and just change the value connecting to the output. For example, in the Seventeam ST-230WHF unit shown in the accompanying photos, pin 1 of the TL494 is the non-inverting input of the relevant error amplifier. It has 3.9kΩ resistor from pin 1 to ground and its reference (set by a voltage divider connected to pin 2) is +2.5V.

We want an output of +13.5V, so we need to calculate a new value for the resistor from pin 1 to the new

13.5V output. From here it is a simple ratio calculation.

R = 3.9kΩ(13.5/2.5 - 1)
= 3.9kΩ x 4.4
= 17.2kΩ

So you merely have to replace the original resistor with 15kΩ and 2.2kΩ resistors in series.

Note: it is possible that the overvoltage monitoring network to one of the comparators in the LM339 may also need modifying to allow it to properly work with the new voltage output.

The process of the calculating resistor is similar to that above; leave the resistor from the relevant comparator input to ground in place and calculate a new value for the resistor connected to the output.

Note that the final output voltages may not be exactly 13.5V regulated due to resistance tolerances and the tolerance of the 5V reference from the TL494.

Check that the potential dividers so formed are connected between the new 13.5V line and ground. Jumpers may be needed.

If the supply proves to be sensitive to RF fields, 100nF (0.1μF) monolithic capacitors fitted between ground and all used inputs and outputs of the ICs should fix the problem. (Editor's note: the addition of these capacitors will severely reduce the transient response of the supply and so it should only be done if the unit is used in conjunction with a radio transmitter).

The configuration of the final output connections is left to the constructor's requirements. Remember that these connections will have to handle up to 18A or so.

The board should now be ready for its first test. Note that you will still need a minimum load such as a 47Ω 5W resistor. Repeat the pre-test procedure, using if necessary the 33Ω and 47Ω resistors connected in series across the output terminations. Hopefully the earlier waveforms will be observed.

If the connections to pin 4 of TL494 have been removed earlier, restore these connections and check if the oscillations cease as the voltage is increased to about 14V.

If all is well and the modified board behaves as expected you are now ready for the first big test.

Reassemble the supply into its case. Make sure that all connections are correct and close the case. Place a test load, (eg, a 12V 50W halogen lamp) across the output, plug in to the 240VAC mains and switch on.

If the globe lights, congratulations!

Final testing can now proceed using a series of loads to measure the output current and voltage.

If the globe does not light, switch off, unplug and wait for at least 15 minutes to discharge the high voltage capacitors, before opening the case.

If the globe "blows" there is a good chance the output voltage sensing circuit is not correctly connected.

Further reading:

Making use of an old PC power supply, SILICON CHIP, Dec 1998. **SC**

And here's the proof that it all works, with this test set-up following reassembly. The wooden contraption at right is a home-made dummy load (hey, don't knock it: it works!). The dmm shows that we have achieved a perfect 13.5V output, while the ammeter (centre of pic) is reading almost 20A. Don't even think about such a test before the lid is on the case!

PC BOARD DESIGN TUTORIAL

Designing a Printed Circuit Board is regarded as a black art by many people but modern PC board software does a great deal to streamline the process. This is the first of a series of tutorial articles on PC board design, covering single layer, double-sided and multi-layer boards.

Part 1: by David L. Jones*

You've designed your circuit and perhaps even built a working prototype. Now it's time to turn it into a nice Printed Circuit Board design.

For some designers, producing the PC board will be a natural and easy extension of the design process. But for others it can be a very daunting task.

There are even very experienced circuit designers who know very little about PC board design, and they leave it up to the "expert" specialist PC board designers.

Many companies even have their own dedicated PC board design departments. This is not surprising, considering that it often takes a great deal of knowledge and talent to position maybe hundreds of components and thousands of tracks into an intricate (some say artistic) design that meets a whole host of physical and electrical requirements.

Proper PC board design is a crucial part of an electronic product. In many designs (such as high-speed digital, low level analog and RF), the PC board layout can make or break the operation and electrical performance of the design. It must be remembered that PC board tracks have resistance, inductance and capacitance, just like your circuit does.

This article is presented to take some of the mystery out of PC board design. It gives some advice and "rules of thumb" on how to design and lay out your PC boards in a professional manner.

It is, however, quite difficult to "teach" PC board design. There are many basic rules and good practices to follow but apart from that, PC board design is a highly creative and individual process. Many PC board designers like to think of PC board layouts as works of art, to be admired for their beauty and elegance. "If it looks good, it'll work good" is an old catch phrase.

Let's have a go, shall we...

How it used to be done

Back in the pre-computer CAD days, most PC boards were designed and laid out by hand using black (or coloured) adhesive tapes and pads on clear drafting film. Many hours were spent slouched over a fluorescent light box, cutting, placing, ripping up and routing tracks by hand. Bishop Graphics, Letraset and even Dalo pens will be names that evoke fond or perhaps not-so-fond memories.

Even before that, literally at the dawn of the PC board age (which believe it or not was only around WWII), patterns were laboriously drawn using pen and ink. You can imagine how popular were the draftsmen (or probably draughtsmen in those days!) who made a mistake – and even more so, the designer who made a mistake in the first place and tried to blame it on the hapless draftsman!

Those days are well and truly gone, with computer-based PC board design having replaced hand layout completely in professional electronics and largely in hobby electronics.

Computer-based CAD programs allow the utmost flexibility in board design and editing over the traditional techniques. What used to take hours can now be done in seconds.

PC board design packages

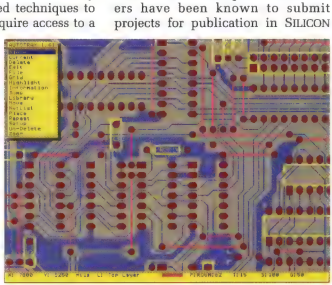
There are many PC board design packages available on the market, a few of which are freeware, shareware or limited component full versions. Protel is the defacto industry standard package in Australia. Professionals use the expensive high-end Windows-based packages such as Protel 99SE and DXP. Hobbyists use the excellent freeware DOS-based Protel

AutoTrax program, which was, once upon a time, the high-end package of choice in Australia. Confusingly, there is now another Windows-based package called AutoTrax EDA. This is in no way related to the Protel software.

This article does not focus on the use of any one package, so the information can be applied to almost any PC board package available. There is, however, one distinct exception. Using a PC board-only package which does not have schematic capability greatly limits what you can do. Many of the more advanced techniques to be described later require access to a compatible schematic editor program. This will be explained when required.

While you can download many software packages from the 'net, be aware that many are not widely used (if used at all) in Australia. It's no good choosing a package and producing a brilliant PC board if the manufacturer you choose cannot handle the file that the package generates.

Similarly, you should never use a "paint" or drawing package to knock-up a PC board pattern. Invariably, you will find it cannot be produced. (Readers have been known to submit projects for publication in SILICON CHIP with a PC board produced in, for example, Corel Draw. While it's a great drawing package, most PC board manufacturers cannot use any of the myriad of file types it produces).



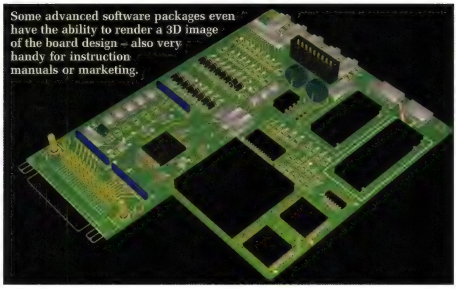
This is a screen grab from the DOS-based Autotrax PC board layout program. It doesn't have all the bells and whistles of modern packages such as Protel (which in fact evolved from Autotrax) but we wouldn't mind betting that there are still probably more PC boards designed using this (now) freeware package than any other, at least here in Australia.

Standards

There are industry standards for almost every aspect of PC board design. These standards are controlled by the former Institute for Interconnecting and Packaging Electronic Circuits, who are now known simply as the IPC (**www.ipc.org**). There is an IPC standard for every aspect of PC board design, manufacture, testing and anything else that you could ever need. The major document that covers PC board design is IPC-2221, "Generic Standard on Printed Board Design". This standard superseded the old IPC-D-275 standard (also Military Std 275) which has been used for the last half century.

Local countries also have their own various standards for many aspects of PC board design and manufacture but by and large, the IPC standards are the accepted industry standard around the world.

Printed Circuit Boards are also known (some would say, more correctly known) as Printed Wiring Boards, or simply Printed Boards. But



Some advanced software packages even have the ability to render a 3D image of the board design – also very handy for instruction manuals or marketing.

we will settle on the more common term PC board for this article.

The schematic

Before you even begin to lay out your PC board, you MUST have a complete and accurate schematic (circuit) diagram.

Many people jump straight into the PC board design with nothing more than the circuit in their head or roughly drawn with no pin numbers and without any logical order. If you don't have an accurate schematic then your PC board will most likely end up a mess and take you twice as long as it should.

"Garbage-in, garbage-out" is an often-used quote that applies equally well to PC board design. A PC board design is a manufactured version of your schematic, so it is natural for the PC board design to be influenced by the original schematic. If your schematic is neat, logical and clearly laid out, then it really does make your PC board design job a lot easier.

Good practice will have signals flowing from inputs at the left to outputs on the right. Electrically important sections should be drawn correctly, the way the designer would like them to be laid out on the PC board. Bypass capacitors should be put next to the component they are meant for.

Little notes on the schematic that aid in the layout are very useful. For instance, "this pin requires a guard track to signal ground" makes it clear to the person laying out the board what precautions must be taken.

Even if it is you who designed the circuit and drew the schematic, notes not only remind you when it comes to laying out the board but they are also useful for people reviewing the design. Your schematic really should be drawn with the PC board design in mind.

Imperial and metric

The first thing to know about PC board design is what measurement units are used, as they can be awfully confusing!

As any long-time PC board designer will tell you, you should always use imperial units (ie, inches) when designing PC boards. This isn't just for the sake of nostalgia. The majority of electronic components were (and still are) manufactured with imperial pin spacing. So this is no time to get stubborn and refuse to use anything but metric units. Metric will make the laying out of your board a lot harder, messier and may even make it more expensive to produce. So if you only learnt metric units, then you had better start learning about inches and how to convert them.

An old saying for PC board design is "thou shall use thous". A "thou" is 1/1000th of an inch, and is universally used and recognised by PC board designers and manufacturers everywhere. So start practising speaking in terms of "10 thou spacing" and "25 thou grid"; you'll sound like a professional in no time!

Now that you understand what a thou is, we'll throw another spanner in the works with the term "mil" (or "mils"). 1 "mil" is the same as 1 thou, NOT to be confused with the millimetre (mm) which is often spoken the same as "mil". The term "mil" comes from 1 thou being equal to 1 milli-inch.

As a general rule, avoid the use of "mil" and stick to "thou"; it's less confusing when trying to explain PC board dimensions to those metricated non-PC board people.

Some PC board designers will tell you not to use metric (ie, millimetres) for ANYTHING to do with a PC board design. In the practical world though, you'll have to use both imperial inches (thous) and the metric millimeter (mm). So which units do you use for what? As a general rule, use thous for tracks, pads, spacings and grids, which are most of your basic "design and layout" requirements. Only use mm for "mechanical and manufacturing" requirements like hole sizes and board dimensions.

You will find that most PC board manufacturers will follow these basic guidelines, when they ask you to provide details for a quote to manufacture your board. Most manufacturers use metric size drills, so specifying imperial size holes really is counter-productive and can be prone to errors.

Just to confuse the issue even further, there are many components (new surface mount parts are an example) which have metric pin spacing and dimensions. So you'll often have to design some component footprints using metric grids and pads. Many component datasheets also have metric dimensions even though the lead spacing is on an imperial grid. If you see a "weird" metric dimension like 1.27mm in a component, you can be pretty sure it actually has a nice round imperial equivalent. In this case, 1.27mm is 50 thou.

Yes, PC board design can be confusing!

So whatever it is you have to do in PC board design you'll need to become an expert at imperial to metric conversion and vice-versa. To make your life easier, all the major PC board drafting packages have a single "hot key" to convert between imperial and metric units instantly ("Q" on Protel for instance). It will help you greatly if you memorise a few key conversions, like 100 thou (0.1 inch) = 2.54mm and 200 thou (0.2 inch) = 5.08mm etc

Values of 100 thou and above are very often expressed in inches instead

```
CURRENT
Arc Line Width  : 20
Cursor Mode     : Absolute
Floating Origin : 0,0
Grid            : Imperial
Layer           : Bottom Layer
Pad Type        : ROUND50
Pad Orientation : Normal
Track Width     : 25
String Size     : 60
String Lines    : 10
Via Size        : 50
Via Hole Size   : 28
```

You can easily check your current setup – this one (from Autotrax) shows (among other things) that we are are using imperial measurement, we are working on the bottom layer (a single-sided board), our pads are 50 thou round and our track width is 25 thou. Any of these defaults can be changed at will or edited for specifics.

of thous. So 0.2 inch is more commonly used than 200 thou.

1 inch is also commonly known as 1 "pitch". So it is common to hear the phrase "0.1 inch pitch", or more simply "0.1 pitch" with the inch units being assumed. This is often used for pin spacing on components such as ICs or MKT capacitors.

100 thou is a basic "reference point" for all aspects of PC board design and a vast array of common component lead spacings are multiples or fractions of this basic unit. 50 and 200 thou are the most common.

Along with the rest of the world, the IPC standards have all been metricated and only occasionally refer to imperial units. This hasn't really converted the PC board industry though. Old habits die hard and imperial still reigns supreme in many areas of practical usage.

Snap to grid!

The second major rule of PC board design, and the one most often missed by beginners, is to lay out your board on a fixed grid.

This is called a "snap grid", as your cursor, components and tracks will "snap" into fixed grid positions – not just any size grid mind you, but a fairly coarse one. 100 thou is a standard placement grid for very basic through-hole work, with 50 thou being a standard for general tracking work, like running tracks between through-hole pads.

For even finer work, you may use a 25-thou snap grid or even lower. Many designers will argue over the merits of a 20-thou grid vs a 25-thou grid for instance. In practice, 25 thou is often more useful as it allows you to go exactly half way between 50-thou spaced pads.

Why is a coarse snap grid so important? It's important because it will keep your components neat and symmetrical; aesthetically pleasing, if you like. It's not just for aesthetics though – it makes future editing, dragging, movement and alignment of your tracks, components and blocks of components easier as your layout grows in size and complexity.

A bad and amateurish PC board design is instantly recognisable, as many of the tracks will not line up exactly in the centre of pads. Little bits of tracks will be "tacked" on to fill in gaps etc. This is the result of not using a snap grid effectively.

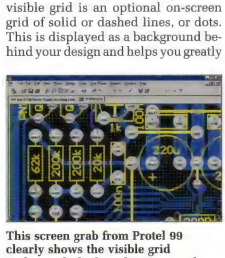
Good PC board layout practice would involve you starting out with a coarse grid like 50 thou and using a progressively finer snap grid if your design becomes "tight" on space. Drop to 25 thou and 10 thou for finer routing and placement when needed. This will do for 99% of boards.

Make sure the finer grid you choose is a nice even division of your standard 100 thou. This means 50, 25, 20, 10, or 5 thou. Don't use anything else!

A good PC board package will have hotkeys or programmable macro keys to help you switch between different snap grid sizes instantly, as you will need to do this often.

Visible grid

There are two types of grids in a PC board drafting package – a snap grid as discussed and a "visible" grid. The visible grid is an optional on-screen grid of solid or dashed lines, or dots. This is displayed as a background behind your design and helps you greatly in lining up components and tracks. You can have the snap grid and visible grid set to different units (metric or imperial) and this can be helpful. Many designers prefer a 100 thou visible grid and rarely vary from that.



This screen grab from Protel 99 clearly shows the visible grid underneath the board pattern and component layout. The grid is set up to 25 thou – again, we are working in imperial measurement.

Some programs also have what is called an "Electrical" grid. This grid is not visible but it makes your cursor "snap" onto the centre of electrical objects like tracks and pads, when your cursor gets close enough. This is extremely useful for manual routing, editing and moving objects.

One last type of grid is the "Component" grid. This works the same as the snap grid but it's for component movement only. This allows you to align components up to a different grid. Make sure you make it a multiple of your Snap grid.

When you start laying out your first board, snap grids can feel a bit "funny", with your cursor only being able to be moved in steps, unlike normal paint type packages which everyone is familiar with. But it's easy to get used to and your PC board designs will be one step closer to being neat and professional.

Working from the top

PC board design is always done looking from the top of your board, looking down through the various layers as if they were transparent. This is how all the PC board packages work (and how all PC boards are depicted in SILICON CHIP).

The only time you will look at your board from the bottom is for assembly or checking purposes. This "through the board" method means that you will have to become skilled at reading text, on the bottom layers, as a mirror image – get used to it!

Tracks size & spacing

There is no recommend ed standard for track sizes. What size tracks you use will depend on (in order of importance) the electrical requirements of the design, the routing space and clearance you have available and your own preferences. Every design will have a different set of electrical requirements which can vary between tracks on the board. All but basic non-critical designs will require a mixture of track sizes. As a general rule though, the wider the tracks, the better. Wider tracks have lower DC resistance and therefore higher current capacity,

Track Width Reference Table (for 10°C temp rise)			
Current (Amps)	Width (thou) for 1oz	Width (thou) for 2oz	Resistance milli-ohms/Inch
1	10	5	52
2	30	15	17.2
3	50	25	10.3
4	80	40	6.4
5	110	55	4.7
6	150	75	3.4
7	180	90	2.9
8	220	110	2.3
9	260	130	2.0
10	300	150	1.7
Note: Values are approximate and have been rounded for clarity			

Just like any conductor, tracks on a PC board have a certain resistance which must be taken into account when designing a board carrying any significant current. 1oz board is by far the most used in Australia.

lower inductance, can be easier and cheaper for the manufacturer to etch, and are easier to inspect and rework.

The lower limit of your track width will depend on the "track/space" resolution that your PC board manufacturer can produce. For example, a manufacturer may quote a 10/8 track/space figure. This means that tracks can be no less than 10 thou wide and the spacing between tracks (or pads or any part of the copper) can be no less than 8 thou. The figures are almost always quoted in thous, with track width first and then spacing.

Real world typical figures are 10/10 and 8/8 for basic boards. The IPC standard recommends 4 thou as being a lower limit. Once you get to 6 thou tracks and below though, you are getting into the serious (and expensive) end of the business and you should be consulting your board manufacturer first. The lower the track/space figure, the greater care the manufacturer has to take when aligning and etching the board. They will pass this cost on to you, so make sure that you don't go any lower than you need to. As a guide, with "home made" PC board manufacturing processes like laser printed transparencies and pre-coated photo resist boards, it is possible to easily get 10/10 and even 8/8 spacing.

Just because a manufacturer can achieve a certain track/spacing, it is no reason to "push the limits" with your design. Use as big a track/spacing as possible unless your design parameters call for something smaller.

As a start, you may like to use 25 thou for signal tracks, 50 thou for power and ground tracks and 10-15 thou for going between IC and component pads. Some designers though like the "look" of smaller signal tracks like 10 or 15 thou, while others like all of their tracks to be big and "chunky". Good design practice is to keep tracks as big as possible and then to change to a thinner track only when required to meet clearance requirements.

Necking

Changing your track from large to small and then back to large again is known as "necking" or "necking down". This is often required when you have to go between IC or component pads. This allows you to have nice big low impedance tracks, but still have the flexibility to route between tight spots.

In practice, your track width will be dictated by the current flowing through it and the maximum temperature rise you are willing to tolerate. Remember that every track will have a certain amount of resistance, so the track will dissipate heat just like a resistor; the wider the track, the lower its resistance. The thickness of the copper on your PC board will also play a part, as will any solder coating finish.

The thickness of the copper on the PC board is nominally specified in ounces per square foot, with 1oz copper being the most common. You can order other thicknesses like 0.5oz, 2oz and 4oz. The thicker copper layers are useful for high current, high reliability designs.

The calculations to figure out a required track width based on the current and the maximum temperature rise are a little complex. They can also be quite inaccurate, as the standard is based on a set of non-linear graphs based on measured data from around half a century ago. These are still reproduced in the IPC standard.

A handy track width calculator program can be found at **www.ultracad.com/calc.htm**, and gives results based on the IPC graphs.

As a rule of thumb, a 10° Celsius temperature rise in your track is a nice safe limit to design around. A handy reference table has been included in this article to give you a list of track widths vs current for a 10°C rise. The DC resistance in milli-ohms per inch is also shown. Of course, the wider the track the better, so don't just blindly stick to the table.

Pads

Pad sizes, shapes and dimensions will depend not only on the component you are using but also the manufacturing process used to assemble the board, among other things. There are lots of standards and theories behind pad sizes and layouts and these will be explained later. Suffice it to say at this stage that your PC board package should come with a set of basic component libraries that will get you started. For all but the simplest boards though, you'll have to modify these basic components to suit your purpose. Over time you will build up your own library of components suitable for your own requirements.

There is an important parameter known as the pad/hole ratio. This is the ratio of the pad size to the component lead hole size in that pad. Each manufacturer will have a minimum specification for this. As a simple rule of thumb, the pad should be at least 1.8 times the diameter of the hole or at least 0.5mm larger. This is to allow for alignment tolerances on the drill and the artwork on the top and bottom layers. This ratio gets more important the smaller the pad and hole become, and is particularly relevant to vias (these will be explained later).

There are some common practices used when it comes to generic component pads. Pads for leaded compo-

nents like resistors, capacitors and diodes should be round, with around 70 thou diameter being common. Dual In Line (DIL) components like ICs are better suited with oval shaped pads (60 thou high by 90-100 thou wide is common). Pin 1 of the chip is commonly a different pad shape, usually rectangular, with the same dimensions as the other pins.

Most surface mount components use rectangular pads (with circular ends) and the pads should not be any wider than the component itself. Surface tension of the molten solder is an issue and if the wrong pads are used, surface tension can pull the component off line or even upright.

Other components that rely on pin numbering, like connectors and SIP resistor packs, should also follow the "rectangular pin 1" rule.

Octagonal pads are seldom used and should generally be avoided. As a general rule, use circular or oval pads unless you need to use rectangular.

Vias

Vias connect the tracks from one side of a double-sided board to another, by way of a hole in the board.

On all but cheap and low-end commercial prototypes, vias are made with electrically plated holes, called "Plated Through Holes" (PTH). Plated through holes allow electrical connection between different layers on your board.

What is the difference between a via and a pad? Practically speaking there is no real difference – both are electrically plated in the "electroless" process but vias are subsequently hidden by the solder mask. So there are differences when it comes to PC board design packages. Pads and vias are, and should be, treated differently. You can globally edit them separately and do some more advanced things to be discussed later. So don't use a pad in place of a via or vice-versa.

Holes in vias are usually a fair bit smaller than component pads, with 0.5-0.7mm being typical (although they should be larger when they need to carry substantial current).

Using a via to connect two layers is commonly called "stitching", as you are effectively electrically stitching both layers together, like threading a needle back and forth through material. Throw the term "stitching" a few times into a conversation and you'll really sound like a PC board professional!

Clearances for non-mains electrical conductors

Voltage (DC or Peak AC)	Clearance (mm)		
	Internal	External (<3050m)	External (>3050m)
0-15V	0.05mm	0.1mm	0.1mm
16-30V	0.05mm	0.1mm	0.1mm
31-50V	0.1mm	0.6mm	0.6mm
51-100V	0.1mm	0.6mm	1.5mm
101-150V	0.2mm	0.6mm	3.2mm
151-170V	0.2mm	1.25mm	3.2mm
171-250V	0.2mm	1.25mm	6.4mm
251-300V	0.2mm	1.25mm	12.5mm
301-500V	0.25mm	2.5mm	12.5mm

The Australian design rules specify minimum spacing between tracks for mains wiring (see text); for everything else these figures should be considered minimum. "Internal" means tracks inside a multi-layer board, "external" are tracks on a single-sided or double-sided board. The < and >3050m means the height above sea level at which the PC board will be used.

Polygons

"Polygons" are available on many PC board packages. A polygon automatically fills in (or "floods") a desired area with copper, which "flows" around other pads and tracks. They are very useful for laying down ground planes. Make sure you place polygons after you have placed all of your tacks and pads.

Polygons can either be "solid" fills of copper or "hatched" copper tracks in a criss-cross fashion. Solid fills are much preferred. Hatched fills result in much larger file sizes and are no longer needed to avoid problems with board warpage.

Track clearances

Electrical clearances are an important requirement for all boards. Too tight a clearance between tracks and pads may lead to "hair-line" shorts and other etching problems during the manufacturing process. These can be very hard to find once your board is assembled. Once again, don't "push the limits" of your manufacturer unless you have to; stay above their recommended minimum spacing, if at all possible.

At least 15 thou is a good clearance limit for basic through-hole designs, with 10 thou or 8 thou being used for more dense surface mount layouts. If you go below this, it's a good idea to consult your PC board maker first.

For 240V mains on PC boards there are various legal requirements, and you'll need to consult the relevant standards if you are doing this sort of work. As a rule of thumb, an absolute minimum of 8mm (315 thou) spacing should be allowed between 240V tracks and isolated signal tracks. Good design practice would dictate that you would have much larger clearances than this anyway.

For non-mains voltages, the IPC standard has a set of tables that define the clearance required for various voltages. A simplified table is shown here. The clearance will vary depending on whether the tracks are on internal layers or the external surface. They also vary with the operational height of the board above sea level, due to the thinning of the atmosphere at high altitudes. Conformal coating (a non-conductive spray often applied over the tracks to resist moisture, corrosion, etc) also improves these figures for a given clearance. This is often used on military spec PC boards.

Phew! That's probably enough to take in for one month. Next, we will look at component placement and design criteria, along with basic routing (or tracking), applying those "finishing touches" which make the difference between an average board and a great board – and we'll also look at the differences between single-sided boards and double sided (or multi-layer) boards. Stay tuned! SC

* david@alternatezone.com

SERVICEMAN'S LOG

TV servicing is getting complicated

Now that I am getting to see more modern TVs and get acquainted with their hi-tech digital circuitry, I am beginning to appreciate the simpler TVs of 10 or more years ago. Even base models now have extensive digital circuitry with protection circuits everywhere.

Does this mean that the new sets are more reliable and cheaper to fix? No, I really don't think so, as it is the new high-tech circuits that are now giving the most trouble – and they are much more difficult to troubleshoot as well.

The digital circuits normally consist of surface-mount components on PC boards with very fine "spider-web" tracks. These boards, which are also often double-sided, are easily ruined in a corrosive (eg, salt-laden) atmosphere and replacement boards are sometimes expensive and difficult to obtain. And, of course, the new module often requires reprogramming after it has been installed.

Unfortunately, these boards are rarely repairable to component level and due to their complexity, can suffer from a range of unusual intermittent faults. Furthermore, access to diagnostic software also requires a service manual which often isn't available unless you are a service agent. Similarly, specialised diagnostic tools are often only available to selected agencies that can afford them.

Is this really a big step forward? Comparing a 34cm or 48cm TV today with that of the eighties, there really is very little difference in picture and sound quality. It is only in the large screen sets with multiple options that you can better understand the reason for their complexity.

Traditional bread and butter faults like flyback transformer failure now often lead to multiple chain reactions as they ripple back through small signal circuits, taking out surface mounted transistors and diodes – especially in protection circuits. By contrast, in the old days, if a flyback transformer failed, it would probably just take out the line output transistor and the beam limiting resistor.

A few quick jobs

I recently had a Philips 21PT238A/75R PV4 chassis in for service. In this case, the EHT had arced out of its insulation and had taken out the vertical output IC (IC7960, TDA9302H). I replaced both parts, using a substitute HR8304 for the flyback transformer, but the set still wouldn't start, with just the front LED flashing.

I checked all the diodes (about 10) around the flyback transformer to find that D6444, D6492 & D6484 were all short circuit or leaky. Unfortunately, working out what value they were was a bit more difficult as I couldn't find a circuit that exactly matched this set.

In the end, I found a combination of different circuits that showed that D6444 was a 15V zener diode in series with D6447 (also 15V). In fact, 22V zeners were originally used in the set so I replaced D6444 only with another 22V zener. D6492 was a 1N4148, while D6484 was meant to be a 13V zener but the original was a 16V unit and so I fitted the same again.

After setting up the screen control and focus, the set was once again performing properly.

I also had a very old NEC N1426 (white plastic cabinet from the late 1980s). Interestingly, this was one of the last NEC-made sets (from Rank Arena) using the PWC-2188A chassis. Later production models of the N-1426A were made by Daewoo (C38N chassis) in Korea and the only external difference was the addition of one extra control in the front.

This particular set had low distorted sound which I traced down to the bias resistor R310 (82kΩ) going high.

By contrast, I have another Philips with no sound which I still haven't managed to solve as there is a fault in the Digital Sound Enable circuitry and I haven't got as far as getting the exact circuit for the control logic! There is sound output from the IF circuitry and the audio output amplifier and speaker works – it's just the bit in between!

More often than not, these digital circuits are intermittent and the fault is random. Sometimes, the only clue to be had is the error code but even that will be lost if the microprocessor and/or EEPROM itself is faulty.

A faulty Akai

I had another Akai CT2867AT come in recently with no sync when cold. Akai is now pretty much an endangered species with little or no spare parts obtainable anywhere. This was a 1996 chassis built 66cm TV.

Because the fault only showed for the first 5-10 minutes or so, I decided to wait for it to work and then hit it with freezer. IC302 AN5601K seemed

Items Covered This Month

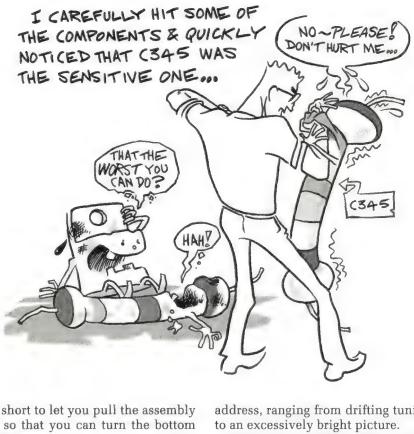
- Philips 21PT238A/75R PV4 TV set.
- NEC N1426 TV set.
- Akai CT2867AT TV set.
- Sharp DV7988X TV set.
- Sony KV-S29MH1 TV set.
- Panasonic TC21S10A TV set (MX3 chassis).
- Philips 21GR6756/74R TV set (G110S chassis).
- Panasonic TC33AV1 TV set (M16M chassis).

to be the most sensitive to this treatment, so I replaced it. But it wasn't to be – the fault was still there.

Feeling somewhat annoyed, I persevered and replaced the more obvious electrolytic capacitors in the sync circuit. I changed C322, C348, C338 & C312 without result, before moving on to the power supplies where I changed C409, C410, C341 & C340.

However, I still wasn't getting anywhere. A check with the CRO showed that the video signal and sync pulses were arriving at the IC and the voltages around it were as expected. And so I went back to the freezer idea.

This time, I carefully hit some of the components around the IC and quickly noticed that C345 was the sensitive one. Fitting a new 3.3µF 50V capacitor fixed the problem. Obviously, the first time I used the freezer, it had bounced off the IC and hit this capacitor, causing me to mistakenly think that the IC was the culprit.



The big Sharp

A large 33-inch (78cm) "telly" was delivered to my workshop by two strong young men and my instructions were to fix it if it was under $300. Mrs Serviceman had fortunately steered them directly to my workbench, so no further lifting was required.

The set was a Sharp DV7988X using an 8PLP chassis circa 1992 and employed a 78cm picture tube. Fortunately, this was a basic TV without many sophisticated digital circuits and its fault was that it was dead.

However, strictly speaking, it wasn't completely dead, with the red standby LED coming on. And when it was first switched on, it would try to start up, with the Green LED coming on and then going off. Furthermore, relays could be heard clicking inside and there was even the rush of EHT but it was soon back to "standby".

This was the first time I had seen this model and, from the symptoms, it seemed like a protection circuit was preventing it from starting. Interestingly, there was no sound at all.

I ordered the service manual and while I was waiting for it, I removed the chassis and checked it carefully for dry joints and other obvious problems. The set is essentially built on two horizontal PC boards at the bottom and one vertical board for the power supply. As usual, the leads are too short to let you pull the assembly out so that you can turn the bottom boards over.

Eventually, the circuit arrived and, mainly because I didn't really know where to start, I began by measuring the voltages out of the switchmode power supply. These were all OK except that there was no -27V rail. This could either be due to a problem with the source or the load.

A quick check with a DMM showed that the rail measured a short circuit to ground. It turned out that one of the diodes in D702 (RH-DX0284CEZZ) – a double-diode TO-220 package – was short circuit. Replacing it completely fixed the set and the sound.

An examination of the circuit reveals that there is a protection circuit sensor on this rail. This trips one of the three relays and switches the set off when there is a fault, which is why the set was shutting down.

A piece of cake, really; I just wish that all jobs were like that!

Another big set

Another extremely heavy set was dropped in with weird intermittent symptoms. This was a 1992 Sony KV-S29MH1 using a G1 chassis (KIRARA BASSO Series).

This is an overseas (German) deluxe model with lots of complex circuitry. It arrived with a list of problems to address, ranging from drifting tuning to an excessively bright picture.

Fortunately, I had worked on this chassis before and was aware of a few of its stock problems. These were mostly due to a series of dry joints on the IC regulators on half a dozen or so modules.

I went over all these joints and when I had reassembled it, all the faults had been fixed except for the brightness problem and a jitter effect on the On Screen Display.

I decided to deal with the brightness fault first and soon discovered that the control voltage from Microprocessor Module M was not varying when the button on the remote was pressed. Instead, it was stuck on 4.8V.

I opened up the Service Mode (press DISPLAY, 5, VOLT, POWER on the remote control) and checked the subbrightness control (31 SBRT = 0D) but it also made no difference. I then checked the screen control adjustments (579V) before concluding that Microprocessor Module M (A-1306-428-A) needed replacing. Unfortunately, it was no longer available.

My next option was to replace the microprocessor (IC005) itself (M372-04M8-A10SP, Part No. 8-759-069-76). Fortunately, this was available but replacing it is another story.

First, the chassis has to be un-

I THEN WENT THROUGH THE *ENTIRE* SERVICE MENU OF 50 ITEMS...

plugged and removed. A metal screen then has to be unsoldered and removed before unsoldering the module itself. That done, the large-scale high-density microprocessor IC has to be removed from the double-sided board.

Before resoldering the module to the motherboard, I took the precaution of removing the two EEPROMS and fitting two IC sockets in their place. The EEPROMs were then installed in the sockets (this was done so that they could later be easily replaced, if necessary). Unfortunately, when I finally got everything back together, the fault remained as before.

Next, I tried swapping the two identical EEPROMS (ST24CO2ABI) and to my total surprise, the fault cleared! However, I now had a new series of problems – some of the tuning menus weren't working.

The EEPROM (ST24C02ABI) used is a very common device so I tried another one in the set. This too gave the same result as swapping them but it also let me establish which of the two ICs was the crook one. It was the top one – IC002. However, despite this being such a common device, it is no longer available from Sony for this set (Part No. 8-759-043-86 which, presumably, is programmed with this chassis' options).

I then decided that if I couldn't fix this problem with hardware, I would try software. In the Service Menu, I found I could stop the jittering with the OSD by changing item 46 OSDOE from a "1" to a "0" (CRT Screen Display odd/even inversion default settings).

I then went through the entire service menu of 50 items, checking each one against its default, checking whether it was working and writing down its value. The only one still not having any effect was item 31 (SBBRT) which, though set at OD, varied from OO to FF with no effect on the screen.

I then noticed in the service manual, under "Circuit Adjustments", that there were five extra service commands. Pressing 7 and 0 on the remote saves all the values and made no difference. Similarly, pressing 8 and 0 sets all user controls to the standard state but that still made no difference. Pressing 9 and 0 sets the horizontal frequency automatically, while 2 and 0 writes all the 50Hz data to the 60Hz data or vice versa (not applicable here).

Finally, there was 5 and 0 Service Data initialisation which had the following warning: "Be sure not to use usually". Apart from the poor English, I had no idea how dangerous this measurement was but I had scraped the bottom of the barrel and had no more ideas.

I tried it and that, as they say, was that. Suddenly, everything was perfect and the brightness control worked perfectly. I guess somehow – perhaps because of a power surge – that the data had become corrupted. Resetting it fixed the problem.

The whistling Panasonic

I had another beast in recently which I thought was eminently fixable. It was a Panasonic TC21S10A (MX3 chassis) which was dead and making a whistling sound.

I began by checking the line output transistor and the main B+ rail for shorts. There were none but there was no voltage on the B+ rail at switch on.

From the noise emanating from the set, it was obvious that it was under stress – probably from a short circuit on the secondary. However, it was also possible that the switchmode power supply was not oscillating properly, so I replaced two small 47µF electros – C805 and C825. This had the effect of altering the pitch of the

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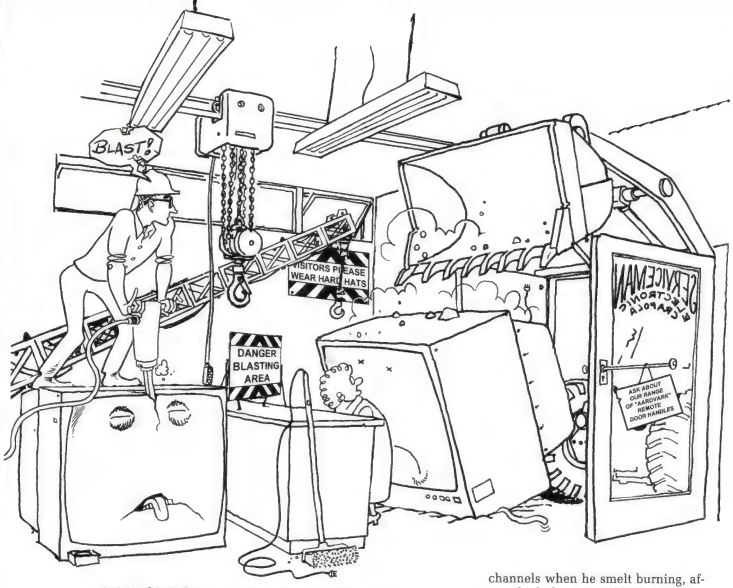

ANOTHER EXTREMELY HEAVY SET WAS DROPPED IN...

whistle slightly, so perhaps I was half right.

After spending some time checking the main B+ rail, I switched my attention to the other voltage rails and soon found what I was looking for – D835 (MA2560) was short circuit. This was a 56V zener diode, which meant that the output from the power supply must have exceeded 56V – probably because the two electros I had already replaced were faulty.

Anyway, a new one fixed the problem.

An embarrassing situation

I had an embarrassing situation last week when a well-known elderly client of mine brought in his 1990 Philips 21GR6756/74R (G110S chassis) with the complaint that the set was dead.

Though an oldie (the set I mean), most faults are well known and relatively easy to fix. I soon found that the 125mA "micro" fuse (1963) in the supply line to the east-west correction circuit had "blown". This fuse often goes open circuit for no apparent reason but I did find a possible cause in the form of dry joints on the east-west coil.

I also upgraded the fuse to 1A (some models actually have a link instead of this) and then put the set aside to soak test. Both the picture and sound were excellent.

Two days later, the customer waltzed in and picked his set up. Another straightforward repair – or so I thought.

Then, barely two hours later, a somewhat frazzled client reappeared with his "telly", saying that it had " lasted less than two minutes"! Apparently, he had just plugged it in and changed channels when he smelt burning, after which the set quickly died.

"Oops", I thought – "perhaps I shouldn't have uprated that fuse"!

Anyway, back on the operating table, I found that the fuse was still intact but the horizontal output transistor (7927, 2SD1577) was now short circuit. This indicated that the flyback transformer had gone – was the set normally kept in a damp environment, I wondered.

I replaced the transistor and switched on carefully. The picture took what felt like hours to come on and the set was making noises I didn't like. When the picture did eventually come on, the raster was intermittently distorted in all directions (trapezoidal) and though the picture was good, this was looking serious.

I switched off and removed the deflection yoke to reveal what I suspected – classic shorted turns had begun to cook and melt. This is unusual in Philips TVs except, of course, for the old 2BS chassis employing an

~ AT THIS STAGE, MY COLLEAGUE PERSUADED ME TO CONTINUE THE REJUVENATION PROCESS...

A51EBS60X picture tube. Hang on – that was exactly the tube inside this model too!

Well, regretfully, that is the death knell on this set. Not only are these yokes not sold separately but everyone wants them for their old 2BS sets, so there's not even a chance of obtaining a secondhand one.

I had to refund my client who was not impressed but that's life!

The red Panasonic

I was nearly caught out with a Panasonic TC33AV1 M16M chassis, which came in with a red-only picture. When the service switch was engaged, there was a white line and I immediately jumped to the (wrong) conclusion that this was an electronic drive problem from the jungle IC (IC601, TA8719AN).

However, shorting the cathodes of the CRT to ground momentarily while watching the screen told an entirely different story – the red was intensely bright but blue and green were both pathetically dull.

A check with my CRT analyser showed that though the cut-offs were good, the drive was as low as 0.1mA (as opposed to 0.6mA for red). An 80cm TV set can cost over $1000 to replace, so I decided to give it a "tickle" with the rejuvenator as there was nothing to lose. But even with 9V applied to the heaters, I couldn't get any response from the blue and green guns.

At this stage, my colleague persuaded me to continue the rejuvenation process while the set was switched on. This was pretty scary as the EHT is typically 32kV and I was expecting a flashover through the CRT to my machine. However, because the tube was so flat, this didn't happen and with my colleague rapidly switching colours, we finally managed to "kick-start" the guns into conduction and start the rejuvenation process.

In the end, we managed to get both the blue and green guns up to 0.6mA emission but ironically the greyscale tracking was appalling. The set ended up with pink highlights, green mid-contrast and blue "low-lights". Still, it was worth a try as the CRT had little or no life left in it anyway. **SC**

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Cat. LA-5425 $449

50MHz Frequency Meter Kit

Ref: Silicon Chip October 2003. Testing far beyond the reach of most multimeters, and into the realm of an expensive Oscilloscope. It features autoranging, a large 8 digit LCD readout, and is very accurate. Kit supplied with PCB, case, silk-screened laser cut front panel, LCD, pre-programmed PCB micro, and all electronic components.

NEW

Cat. KC-5369 $69.95

Melcom 8 Sector Alarm Kit with Dialler

Compare the price of this full kit with others on the market with similar features, and you will be impressed. Do it yourself and save a fortune!

Kit Includes:
- 1 x Melcom 8 Sector Panel with Dialler
- 1 x LCD Keypad
- 3 x Proton Quad PIR's
- 1 x 7Ah Back Up Battery
- 1 x Plug Pack 3 Wire Power Supply
- 1 x Strobe Light
- 1 x Indoor Siren
- 2 x Reed/Magnet Assemblies
- 1 x Siren Cover/Outdoor Siren Speaker
- 100m Roll 6 Core Austel Approved Cable
- 1 x 30m Roll 2 Core Cable
- 4 x Deterrent Stickers

SAVE $153.35 on individual parts prices

Cat. LA-5428 $749.00

128MB USB Flash Disk with MP3 Player

- USB Flash Disk doubles as an MP3 player.
- Stores up to 2 hrs of MP3 music.
- No PC software required (drivers are included for Win 98/SE)
- Uses 1 x AAA battery (supplied)
- Tiny size, measures just 76 x 37 x 16mm.
- Includes lanyard & earphones

NEW

Cat. GE-4000 $199

NEW STORE OPENING

Unit 2/3255 Logan Rd., Underwood. Qld. 4119.
Ph: (07) 3841 4888

TORQUE THAT COULD BREAK YOUR WRIST! A remarkable surplus-stock buy!

We were recently contacted by a manufacturer of electric gate closers. Like their gates, they were closing. They had a modest number of motor/gearbox sets that operated the gate mechanisms which they clearly no longer had a need for.

THE MOTOR:

The motor is a 14.4 Volt (nominal 12V) unit made by Johnson Electric model HC683xLLG, 500W max. It is 36mm diameter, draws a considerable 35.5 Amps at 9900RPM showing a torque of 238 m-Nm. It is fitted with a brass pinion gear. The motor has internal fan cooling as well, and then it goes through a sun-gear reduction gearbox.

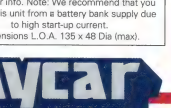
THE GEARBOX:

This comes mounted to the motor. It provides 30-1 stepdown (with a x30 multiplication in torque, of course). The output shaft is, in fact, capable of taking a Jacobs-type chuck. The shaft is threaded 3/8" UNF. Two x 3/8" UNF Hex nuts are included. The shaft also has an internal hole which is 5mm metric, left hand thread. The gearbox also includes a torque clutch. Now here's the interesting bit. The clutch consists of a detent plate which retains a set of steel balls restricted by a spring. The spring pressure dictates the 'give' at a particular torque setting. We provide a drawing of a suitable spacer you can make to program the clutch to only slip at the highest load before stressing the gearbox.

You can buy a cheap 9.6V cordless drill these days for about $30.
It will include a motor, gearbox and some low-spec Ni-Cads. It's not a bad way of getting hold of a fairly torquey motor setup. Or you can get this for $19.95 and get: •Enough torque to almost break your wrist. •Full manufacturers data.
•A far more powerful motor/gearbox than a cheap drill.

This setup is ideal for robotic experimenters, or anyone who needs a compact torquey power source. When we say quantities are limited, we mean it. Thousands of customers in the past have missed our special deals because of limited stock. So you have been told.
Remember also that while you may not need one of these things today, you will at some time in your future.
Buy it NOW, it won't be available when you actually need it.

NEW



Cat. YG-2735 $19.95 ea

Maximum purchase of 10 per customer

The unit comes with data, including speed, efficiency, current draw curves, two shaft nuts and other info. Note: We recommend that you power this unit from a battery bank supply due to high start-up current.
Dimensions L.O.A. 135 x 48 Dia (max).

OVER 5,500 PRODUCTS IN STORE JAYCAR ELECTRONICS

Freecall For Orders 1800 022 888

www.jaycar.com.au

Jaycar ELECTRONICS

GREAT NEW CAR ACCESSORIES!!!

Rear View Mirror with Voice Recorder and Hands-Free Phone Kit

Turn an ordinary rear-view mirror into your car's communications centre. Our unique clip-on mirror has a built-in digital voice recorder and hands-free mobile phone kit. A loudspeaker is built in so the phone sound can be played through the speaker or via the retractable ear piece. See website for full details.
- Mirror width 270mm
- Power cable length 3M
- Phone cable 1.2M

NEW

Cat. GG-2120 $89

Rear View Mirror with Voice Recorder, Hands-Free Phone Kit and Reversing Sensor

Boasting the same great features as the rear view mirror to the left, with the addition of integrated parking sensors and distance display. Just install the mirror and the parking transducers. You will then have a four sensor parking monitor, which warns you of any objects behind your car, and even tells you how far away they are. See website for full details.
Specifications:
- Mirror width 270mm
- Power cable length 3M
- Phone cable 1.2M
- 4 x Parking transducers included
- Transducer cable length 1.5M

NEW

Cat. GG-2122 $189

2 and 4 Door Power Locking Kits for Cars

Add that touch of luxury to your car with these low cost central locking kits. They can be wired to car alarms with a negative triggering locking output, or used with our LR-8831 remote controller for remote locking. Both kits include lock motors, control relay, hardware, and wiring loom.
- 4 door kit shown

NEW

2 Door Kit
Includes 1 master & 1 slave actuator.
Cat. LR-8810 $29.95

4 Door Kit
Includes 1 master and 3 slave actuators.
Cat. LR-8812 $39.95

Car Washer Nozzle Set with Tri-Colour LED's

Dress up your car with these chrome-finished windscreen washer nozzles with built-in tri-colour flashing LED's. Simply screw in-place of old washer nozzles, they make a great deterrent when used with a car alarm.

NEW

WARNING: Illegal to use whilst vehicle is in motion

Cat. LA-5094 $19.95

Lifted Boot Lid Extender

Hold the boot lid of your car down safely while carrying oversized loads. The unit incorporates a strong retractable cable with metal carabineers which clip on and hold the boot lid down. Also features a retractable box cutting knife, and LED flashers. See website for details.

NEW Cat. GH-1100 $24.95

1.3 Mega Pixel Digital Camera

Our highest resolution digital camera yet! It stores up to 26 great photos in high-quality mode and 104 in standard resolution mode. It features a 4-layer glass lens for greater image quality and a fixed focus for easy operation. The camera is simple to use, and is small enough to easily slip into your pocket or purse. See our website for full details.
- Measures 74 x 70 x 28mm.

Cat. QC-3194 $99

300k Pixel Mini Digital Camera

- Measures just 65 x 53 x 21mm
- Weighs just 41grams
- 640 x 480 max resolution
- USB Connection

Cat. QC-3192 $79.95

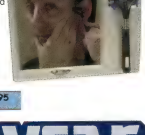
100k Pixel Mini Digital Camera

- Measures just 60 x 43 x 17mm
- 352 x 288 max resolution
- USB Connection

Cat. QC-3190 $49.95

Anti-Fogging Shaving Mirror with Clock

This anti-fog mirror doesn't get steamed up and has a digital clock to keep track of the time. It has in-built LEDs for extra light and is supplied with suction cup, screen hook and hanger cord. Requires 3 x AA batteries (not supplied).



NEW

Cat. GH-1058 $34.95

Bug Trap

A safe and hygienic method of controlling irritating insects. It works by attracting the insects with two UV lights then sucks them through its super quiet fan. Once trapped, insects dehydrate and die. Dead insects are disposed of by sliding out the removable tray. See our website for details.
- Measures 360 x 330 x 185mm.

NEW

Cat. YS-5542 $79

Animated Singing Birds Alarm Clock

The digital clock can also be set to sound on the hour, every hour. It's actually quite smart as you can also set it to sound whenever someone passes by. These birds do more than just chirp, they actually move, with animated beak and tail. Measures: 122(L) x 113(H) x 52(D)mm.

NEW

Cat. XC-0245 $19.95

Happy Halloween

October 31st

Animated Grim Reaper with Sound Effects

Scare anyone who dares come near the Grim Reaper. The sensor sets of a ghoulish scream while the skulls eyes glow red, and just when you think it's all over, the skull jumps out at you! A perfect gag for all those trick-or-treaters. Requires 3 x 'AA' batteries

NEW

Cat. GT-3050 $24.95

Novelty Attack Bat

NEW

When a sound is made nearby, the bat quickly drops down the string then climbs back up, flapping its wings and flashing its eyes, to wait for the next victim. Wingspan 420mm. Requires 2 x AA batteries available separately.

Cat. GT-3052 $19.95

Nasty Witch Sweets Bowl

Scare your guests at Halloween or your next party. When someone reaches into the bowl the witch snaps at them with her broom, and glares with evil red eyes, while letting out a blood curdling shriek and cackling away at you. Requires 3 x 'AA' batteries.

NEW

Cat. GT-3054 $24.95

Fog Machine

We have all seen fog machines in operation and know how dramatic their effects can be. It produces clouds of white fog on demand with its remote control switch. When used in conjunction with mirror balls and other party lighting, beautiful effects can be achieved. Domestic use only.

NEW

1L Fog Juice

Cat. AF-1212 $9.95

Cat. AF-1210 $89.95

DUE LATE OCTOBER

Electroluminescent (EL) Novelty Badges

- Great Halloween novelty
- Multi zone lighting effects
- Really scary theme

Scream Mask Badge

Cat. GG-2110

Fish Badge

Cat. GG-2112

Cemetery Badge

Cat. GG-2114

Happy Halloween Badge

Cat. GG-2116

All Types $14.95 ea

Shocking Skill Tester

Test your skill, but beware; if you fail you will receive a mild electric shock. Move the tester around the face but don't touch the sides.

NEW

Cat. GH-1094 $29.95

Electric Shock Roulette

Play Russian Roulette without the life threatening hazards! Place your finger on the roulette machine and spin. Someone will receive a mild electric shock. Up to four players.

NEW

Cat. GH-1092 $24.95

Musical Bathtub Novelty

Your heart will go Sha-la-la-la-la as you sing along with these animated characters enjoying a vigorous bathtub romp. Great fun for the older members of the family and sure to put a smile on everyone's face. Requires 3 x AA batteries available separately.

NEW

Cat. GH-1090 $24.95

IR Remote Control Jammer

Strike back at the annoying family member who dominates the living room remote control.

- Jams TV, Hi-Fi and Video infra-red remote control signals and stops them from working.
- Batteries included

*Remote control not included

Cat. GH-1084 $9.95

Farting Salt and Pepper Shakers

Entertain or embarrass your friends with these salt and pepper shakers. They make a fart sound when they are tipped upside down.

Great fun around the BBQ!

NEW

Cat. GH-1080 $19.95

Hand Held Electronic Farting Keychain

Simply push the button, to let off a great farting sound. A must for every practical joker. Batteries supplied.

NEW

Cat. GH-1082 $9.95

Remote Control Fart Machine

Simply hide the box near your intended victim, and activate it from a distance with the remote control. Not only will they be embarrassed, they won't even know who is responsible!

NEW

Cat. GH-1088 $19.95

OVER 5,500 PRODUCTS IN STORE
JAYCAR ELECTRONICS

Super High Power Rechargeable Halogen Spotlights

These are **the brightest** halogen spotlights we have ever seen. Great for fishing, camping, 4WD'ing, these lights will be seen for kilometres! Words cannot describe just how bright these spotlights are, so drop into your local store for a look!
YOU WILL NEED SUNSCREEN FOR THESE BABIES!

NEW

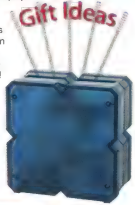
1,000,000 Candlepower
Features an internal 6V 4Ah SLA battery, mains and car charger. 100mm diameter lens.
Cat. ST-3300 $34.95

2,000,000 Candlepower
Features an internal 6V 4Ah SLA battery, mains and car charger. 130mm diameter lens.
Cat. ST-3302 $49.95

3,500,000 Candlepower
Features TWO internal 6V 4Ah SLA batteries, mains and car charger, and a huge 170mm diameter lens! This spotlight will be seen for kilometres!
Cat. ST-3304 $69.95

Oscillating Message Board

This futuristic unit displays a message, time or date, without a solid display. It uses a fast oscillating arm with LED's, which appear to show the message in thin air! It stands approx. 20cm tall. Supplied with mains plugpack.



NEW

Cat. XC-0198 $69.95

Small Scrolling Message Board

Display up to a 60 character message for your family or friends, or mount this unit as a shop display drawing attention to customers. Displays 4 characters at once, scrolling through the message.
Requires 3 x 'AA' batteries.
Display size: 110 x 50mm.

NEW

Cat. XC-0190 $59.95

12 Character LED Message Board Medium Size

Great as a permanent information display for your business or shop window. Enter a message up to 60 characters long with the full keypad built in, or display one of the 26 stored messages. It can also display the time and date.
Display size: 365 x 47mm.
See our website for details.

NEW

Cat. XC-0192 $109.95

12 Character LED Message Board Large Size

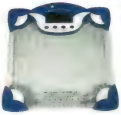
NEW

The biggest in our display board range, this unit offers the best features in a running LED display unit. Up to 60 character messages or time and date can be displayed. Entering messages is easy with the built in keypad. See our website for details.
Display size: 670 x 70mm.

Cat. XC-0194 $149.00

Bathroom Scales with Body Fat Analysis

These scales will calculate the amount of body fat you are carrying. They can be calibrated for use by up to 8 different people. It uses "bio-impedence-analysis" technology to measure the body fat ratio.



Cat. QM-7249 $129.95

2Kg Stainless Steel Kitchen Scales

NEW

Excellent quality Stainless Steel kitchen scales. They feature a resolution of 2g up to 2kg, auto power off, tare function, and are supplied with an 800ml measuring bowl.

Cat. QM-7243 $69.95

Digital Watch with Pulse and Calorie Count

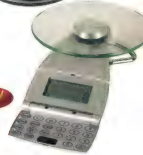
NEW

Keep track of your pulse rate and energy consumption with this easy-to-use digital watch. Features also include an alarm and a stopwatch with split time function. 2 x LR44 batteries included.

Cat. XC-0266 $39.95

3Kg Digital Nutrition Scales

Ideal for those who need to monitor their food intake or are watching their weight, these kitchen scales double as a nutrition calculator for over 470 common food items. They measure calories, kilojoules, cholesterol, protein, fat, carbohydrates and glycaemic index.

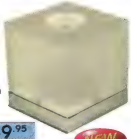


NEW

Cat. QM-7240 $79.95

Aromatherapy Table Lamp

Never runs out of candles! Normally aromatherapy fragrances are heated with a candle which can be messy, inconvenient, and possibly dangerous. This fully approved unit features a small 240V (25 Watt) lamp. The lamp not only heats the oil but is a small attractive unit in itself. When not producing aromas, it can operate as a small table or bedside lamp. Supplied with 3 fragrances, Lavender, Lemongrass, and Sandalwood.
Measures 115 x 115 x 110mm



NEW

Cat. GH-1045 $39.95

Digital Pedometer with FM Radio

NEW

Not only will this little wonder tell you how far you have walked, it can also tell you how many steps it took and how many calories you consumed doing it. The pedometer has an integrated belt clip and an FM radio.

Cat. XC-0264 $29.95

NEW WIRELESS TECHNOLOGY FROM JAYCAR

2.4 GHz Wireless AV Sender

NEW

Share your Audio/Video signals all over the house without the hassle of running cables, and degrading signal quality. Additional receivers are available separately to allow multiple viewing locations from the one source.

Cat. AR-1832 $99

PRICE BREAKTHROUGH

Extra Receiver

Cat. AR-1833 $69

2.4 GHz Wireless AV Sender with IR Remote Control Extender

Similar in design to the AR-1832 (left), with the addition of an Infrared remote control extender. This allows you to control the DVD, Cable TV, or VCR from the remote viewing location.

Cat. AR-1830 $139

NEW

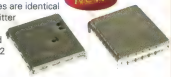
Extra Receiver with IR Extender

Cat. AR-1831 $89

2.4 GHz Wireless AV Sender Modules

NEW

These modules are identical to the transmitter / receiver modules used in our AR-1832 Wireless AV Sender.



They are supplied in a metal case, with pin-outs and data sheets. They only require 5VDC, a few simple components, and associated panel hardware (if required) to get them up and running. The transmitter and receiver modules are sold individually for greater flexibility.

Transmitter Module

Cat. QC-3590 $34.95

Receiver Module

Cat. QC-3592 $49.95

Mini Wireless CMOS Colour Camera with Audio

NEW

Highly covert or mobile surveillance is now very accessible with the use of this 2.4 GHz camera/receiver package. Monitor remote locations up to around 100m with video and audio capture. The camera can be plugged into mains power with the included plugpack or with the 5 volt battery attachment, also included. Actual camera size is a tiny 22mm x 22mm. See Website for details and specs.

Cat. QC-3270 $249

2.4 GHz Wireless CMOS Colour Camera with Audio

NEW

Simple, high quality surveillance with night vision has never been easier to install and operate. It features 12 powerful IR LED's, for excellent 'night vision' capabilities. It is housed in a rugged metal case, and can be powered from a plugpack, or 9V battery. Transmission distance up to 100m. Actual camera size is 43mm dia. See website for details.

Cat. QC-3274 $299

CCD SURVEILLANCE CAMERA SALE!!!

Limited Stock on some models. See our Website for individual details.

B&W Pinhole in Metal Case with Audio

SAMSUNG SENSOR INSIDE

- 380 TV Line Res.
- 90° Lens Angle

Was $109 Save $10

Cat. QC-3475 $99

B&W in Metal Case with Audio

SAMSUNG SENSOR INSIDE

- 400 TV Line Res.
- 92° Lens Angle

Was $169 Save $20

Cat. QC-3476 $149

B&W Pro Style

SAMSUNG SENSOR INSIDE

- 380 TV Line Res.
- 0.5 Min Lux.
- Requires lens

Was $119 Save $15

Cat. QC-3306 $104

B&W Dome Style with IR

Panasonic SENSOR INSIDE

- 380 TV Line Res.
- 92° Lens Angle

Was $209 Save $20

Cat. QC-3443 $189

Colour Pro Style

GREAT ENTRY LEVEL PROFESSIONAL COLOUR CAMERA

- 330 TV Line Res.
- 2.0 Min Lux
- Requires lens

Was $259 Save $25

Cat. QC-3305 $234

Colour Dome Style with IR

SONY SENSOR INSIDE

- 380 TV Line Res.
- 70° Lens Angle

Was $369 Save $40

Cat. QC-3444 $329

Colour Weatherproof with IR

SONY SENSOR INSIDE

- 380 TV Line Res.
- 80° Lens Angle

Was $349 Save $40

Cat. QC-3492 $309

Flickerless Colour Pro Style with Auto Iris Control, IR Capability and Audio

- 420 TV Line Res.
- 1.0 Min Lux (0 with IR Lens)
- Requires lens

SONY SENSOR INSIDE

Was $359 Save $40

Cat. QC-3321 $319

High Res Colour Pro Style with Auto Iris Control and Gen-Lock Function

- 480 TV Line Res.
- 2.0 Min Lux
- Requires lens

SONY SENSOR INSIDE

Was $439 Save $60

Cat. QC-3312 $379

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www.jaycar.com.au

Jaycar ELECTRONICS

OVER 5,500 PRODUCTS IN STORE JAYCAR ELECTRONICS

DISCONTINUED BOOK SELLOUT!!!

Unbeatable Value

Limited qty available. All stock not available in all stores. Call first to check availability.

Cat No	Description	Was	Now	Save
BA1408	Bullock on Boxes	$30.95	$23.95	$7.00
BA1420	Testing Speakers	$79.95	$59.95	$20.00
BA1430	Sound Studio Construction on a Budget	$49.95	$39.95	$10.00
BA1440	Loudspeakers for Musicians	$24.75	$19.75	$5.00
BB7010	30 Simple IC Terminal Block Projects	$15.95	$11.95	$4.00
BB7033	Magic Electronic Projects	$12.95	$9.95	$3.00
BB7054	Intro to Robotics with Lego Mindstorms	$34.95	$27.95	$7.00
BB7305	Electronic Hobbyist Data Book	$14.50	$11.50	$3.00
BC8005	Giant Data Wall Chart	$7.95	$5.95	$2.00
BM2473	303 Circuits	$31.95	$24.95	$7.00
BM2474	304 Circuits	$31.95	$24.95	$7.00
BM2475	305 Circuits	$34.95	$27.95	$7.00
BM2476	306 Circuits	$29.95	$23.95	$6.00
BM2487	VCR Servicing	$27.95	$22.95	$5.00
BM2493	22 Projects Using LM3909	$6.50	$4.50	$2.00
BM2495	Alarm Circuits Manual	$23.95	$18.95	$5.00
BM4566	7400 IC's Data & Comparison Tables	$24.95	$19.95	$5.00
BM4567	CMOS 4000 Data & Comparison Tables	$24.95	$19.95	$5.00
BM4586	Japanese Transistor Data and Tables	$29.95	$23.95	$6.00
BS1500	Easy PIC'n Beginners Guide to PIC Micro	$85.00	$65.00	$20.00
BT1334	Secrets of RF Design	$79.95	$59.95	$20.00

JC80 Double 8" Speaker Kit

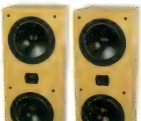
NEW

This brand new speaker kit includes 2 fabulous Vifa 8" Woofers and a Vifa D26 tweeter. The woofers include 30oz magnets, long throw butyl rubber surround, mineral filled mica polycone supported on a very rigid die cast magnesium basket. The tweeter is a high power Vifa D26 which provides accurate response and high performance. The crossovers are pre-built. This kit is based on the ever popular JV60 kit, which we sold for a number of years, and outperformed speakers costing twice the price and more. Power handling is 100WRMS, and impedance is 4 ohms. Limited quantities available, so be quick to avoid disappointment.

"...generous power handling and quite good efficiency so they can really deliver a punch..." See Silicon Chip October for their full review.

Speaker Kit - Pair

Includes 4 woofers, 2 tweeters, 2 crossovers with polyswitches, rear terminals, ports, innerbond, and self tapping screws for mounting speakers and crossovers.



Cat. CS-2580 **$589**

Cabinets – Pair

These are fully built with a light wood grain finish. Grills supplied with speaker cloth mounted. You simply solder the crossover wires and screw the speakers in.

Cat. CS-2582 **$379**

BUY THE WHOLE KIT TOGETHER Cat. AA-0124 **$939 Pr**

Personal PA Systems

Designed to be worn around the waist, the self contained amplifier will help you make yourself heard over a crowd or any background noise. Both systems are surprisingly loud for their size, and are great for small PA applications such as in-store demonstrations, tour guides and lecturers etc. A sensitive microphone is included and is attached to a small ear hook gooseneck that allows 'hands free' operation.

Compact System

Supplied with a 9V battery for power.

NEW

Cat. AM-4054 **$49.95**

Deluxe Rechargeable System

Supplied with charger, requires 6 x AA rechargeable batteries.

Cat. AM-4052 **$99.00**

PLUG N VIEW

Surveillance System

The 'Plug 'N View' do-it-yourself surveillance system is designed for quick and easy installation, yet can be used to develop very sophisticated video monitoring systems. The range consists of a series of cameras, monitors and switchers that simply plug together to form customised surveillance solutions. All cameras in the range use a single cable to carry power, video, audio and PIR signals (where applicable) to simplify installation and operation. But don't be fooled by the simplicity, the Plug 'N View system delivers excellent performance.

See in store for our Plug 'N View surveillance brochure.

3 EASY STEPS TO PLUG N VIEW

1 - Pick a Camera

2 - Pick a Monitor or TV & Switcher

3 - Plug them in

6 Core Alarm Cable – ACA Approved – 30m Roll

Austel approved alarm cable. For use in alarms with diallers. 6 x 7/0.2 flexible stranded conductors in tough outer sheath.

NEW

Cat. WB-1596 **$34.95**

AV-GAD Passive Infrared Detector

This is a top-of-the-line PIR that is one of the best we have sold. It features automatic temperature compensation to increase catch performance in warm temperatures, and reduce false alarms in cold temperatures. See our website for details.

NEW

Cat. LA-5532 **$64.95**

Low Cost Dummy Camera with Motion Detector

This realistic looking dummy camera both looks and acts the part. It has a light dependant resistor detecting movement (changes in ambient light) causing it to pan, giving the impression of active security monitoring.

Cat. LA-5318 **$29.95**

Jaycar ELECTRONICS

Freecall For Orders 1800 022 888

www.jaycar.com.au

OVER 5,500 PRODUCTS IN STORE JAYCAR ELECTRONICS

Handheld Metal Detector

NEW

Security is a high priority in todays world, and this handheld metal detector is an ideal aid. It is compact, lightweight, and beeps whenever the sensor passes over a metal object. It is 400mm long with a 140mm 'sensor area'.

Cat. QP-2272 $69.95

DUE LATE OCTOBER

Heavy Duty Wire Stripper/Cutter/Crimper

Designed for easy wire stripping. The Alloy steel jaws can strip all types of wire from AWG 10-24. It incorporates a precision cutting blade for easy wire cutting, and quality crimping jaws for insulated crimp terminals.

NEW

Cat. TH-1827 $25.95

Precision Mini Metal Lathe Deal

NEW

Industrial quality on a hobby budget! Small hobby lathes are not new, they have been European made and very expensive, or have welded frames and are flimsy. This fantastic unit has a FULL cast iron bed, frame and headstock assembly, just like industriel lathes. It bristles with safety features including a plastic chuck cover which must be down for the machine to operate. This prevents you from starting the lathe with the chuck-key in! We have not seen a product of this quality at this price. **The cutting tools, drill chuck and live centre are all usually sold extra, costing up to $150 more, but are included in the price!!!**

See our website for full features and specifications.

Cat. TL-4000 $899

The lathe is not on display at all stores but is usually in stock. Mail order / Techstore customers, get a quote for road freight.

Optional Extra Floor Stand

Cat. TL-4002 $89.95

That's $107.80 worth of parts already included!

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TAILSTOCK CHUCK & SHANK	Cat TL-4006 $34.95
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2m Cat. WC-7586 $14.95

5m Cat. WC-7588 $19.95

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NEW

This great tool will cut, strip, and crimp flat telephone cable, or Cat5e type cable also. Constructed from high quality carbon steel, it features interchangeable dies and ergonomic design. It also has a brace to lock them closed.

Cat. TH-1936 $59.95

3 Pin XLR Type Extension Cables

NEW

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2m Cat. WA-7041 $9.95

10m Cat. WA-7043 $19.95

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Cat. WV-7585 $8.95

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NEW

This pack includes a PC mount coil former, F16 Ferrite slug, and a PC mount RF screening case. See website for details.

Cat. LF-1227 $2.95

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Used in many rechargeable battery packs for a large range of products. These include radio control cars, boats, and portable appliances such as drills, electric toothbrushes etc.

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NEW KIT

Ref: Silicon Chip September 2003.

A great low cost alternative to expensive current clamp meters. It uses a simple hall effect sensor, and iron ring core setup, and connects to your digital multimeter. It will measure AC and DC current, and has a calibration dial to allow for any magnetising of the core. Much cheaper than pre-built units. Kit supplied with PCB, clamp, case, silkscreened front panel and all electronic components.

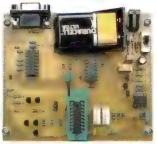
Cat. KC-5368 $34.95

Serial PIC Programmer Kit

NEW KIT

Ref: Silicon Chip September 2003.

This great little programmer can be battery powered! It features a portable, robust design, and has provisions for In Circuit Serial Programming (ICSP) for micros which support this programming feature. This avoids the need to unplug a PIC from it's circuit to make and test changes to the code. It simply connects to your PC's serial port. Kit supplied with PCB, and all electronic components. ZIF socket, serial cable and battery not supplied.



Cat. KC-5367 $39.95

Auto Power-Up Kit

Ref: Silicon Chip July 2003.

- Switches on associated equipment when a 'master' device is powered up.
- Great for computers and home theatre systems.
- Kit includes PCB, electronic components, and silk screened front panel.

Cat. KC-5363 $79.95

PC Infrared Remote Control Interface Kit for PC Based MP3 and DVD Players

Ref: Silicon Chip August 2003.

In conjunction with free Windows remote control software, it can be used to drive a popular DVD player (Win-DVD 4 or 5) and MP3 player (Winamp 3). These are not the only possible uses. If you are a keen programmer, it can be configured to control just about any Windows application. Kit supplied with PCB and all electronic components.

NEW KIT

Cat. KC-5366 $39.95

2A DC-DC Converter Kit

Ref: Silicon Chip June 2003.

- Step up a 12V supply to between 13.8 and 24VDC.
- Efficient switchmode design.
- Kit includes PCB, electronic components, and silk screened front panel.

Cat. KC-5358 $49.95

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Telephone Dialler for Burglar Alarms Kit

Refer SC April 2003

- Dial a preprogrammed phone number via modem
- Can be triggered by N/C or N/O contacts
- Easily programmed via PC
- Primary and secondary telephone number storage

Was $65.00

SAVE $15

Cat. KC-5348 $50.00

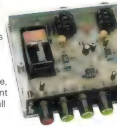
Guitar Overdrive/Distortion Kit

Ref Silicon Chip May 2003

- Adjustable level and tone controls
- Adjustable distortion and a bypass switch
- Kit includes case, silk screened front panel, PCB and all electronic components.
- Battery not supplied.

Was $59.95

SAVE $10



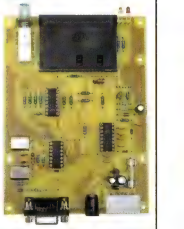
Cat. KC-5353 $49.95

Full Function Smart Card Reader/Programmer Kit

Ref: Silicon Chip July 2003

This great design will program many blank Gold, Silver, and Emerald wafer cards (with relevant loader software) which conform to ISO-7816 pinout standards. PC connection is via the serial port, and the PCB can be powered from a plugpack, 9V battery, or your ATX power supply. Kit supplied with PCB, card socket, and all specified electronic components.

- Jaycar Electronics and Silicon Chip Magazine will not accept responsibility for the operation of this device, its related software, or its potential to be used for unlawful purposes.



Cat. KC-5361 $49.95

SPECIAL BONUS FOR OCTOBER ONLY!

When you purchase a Smart Card Reader Programmer Kit (KC-5361) in October, you can buy a Gold Card (ZZ-8800) for only $10!

(Only when purchased in the same transaction. Only 1 discounted card per kit.)

SAVE $9.95 off total price!

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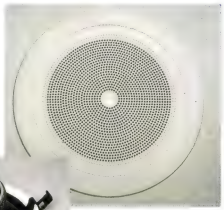
PRODUCT SHOWCASE

Altronic's Aussie One-Shots

Altronic Distributors are very proud of their new "One-Shot" flush-mount ceiling PA speaker/grille combination.

The unique, screwless snap-in design requires only the mounting hole through which the speaker fits.

Designed and manufactured in Australia, the mounting system is said to dramatically reduce installation time of ceiling-mounted PA and emergency/evacuation speakers. Sound reproduction quality is claimed to be good enough for home theatre installations!



When used in conjunction with Altronics' T2314 variable hole saw, installation time into 10-13mm Gyprock or mineral fibre ceilings should be under a minute. For installers putting in a multiple-speaker system in commercial premises, this can mean significant savings.

The flush-mounting grille, available in either black or white (and can also be painted to match colour schemes), will handle a variety of 200mm speakers in both 8Ω and 100V line models. The fire evacuation models comply with AS2220 and come complete with a protective transformer cover, cable restraint plate, 4-way wire protect terminal and 22μF bipolar capacitor for line-monitoring applications.

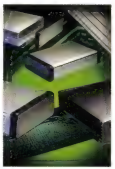
Contact:
Altronic Distributors
PO Box 8350, Perth Business Centre,6849
Tel: 1300 797 007
website: www.altronics.com.au

Makes a good case for . . .

Hammond Electronics Pty has added an additional three sizes to its recently introduced 1455 family of extruded aluminium instrument cases, designed to house PCBs mounted horizontally into internal slots in the body of the case or as an enclosure for any small electronic, electrical or pneumatic instrument.

The new sizes are the 1455J160, 160 x 78 x 27mm;, the 1455L160, 160 x 103 x 30.5mm; and the 1455L220, 220 x 103 x 30.5mm. The two larger sizes accept standard or extended-depth Eurocards.

The cases are available with either two aluminium end panels and optional ABS plastic bezels or with two solid, easy to machine black ABS plastic end panels complete with integral bezel. The body of the enclosure is in either clear or black anodised finish and they are supplied complete with fixings and self-adhesive rubber feet. Optional aluminium flange brackets, replacing the standard end panels, enable the unit to be mounted directly to a shelf or wall are also available



Contact:
Hammond Electronics
GPO Box 812, Adelaide SA 5001
Tel: (08) 8234 0744 Fax: (08)-8356-3652
website: www.hammondmfg.com

SpacePort Modem

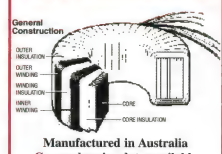
Telelink Communications, distributors of Radiometrix products in the South Pacific and Asia, have introduced the Radiometrix "SpacePort Modem" to their impressive line-up of communications accessories.

It is a low cost, highly integrated intelligent radio packet modem that enables a radio network/link to be simply implemented between a number of digital devices.

The SPM uses addressable data packets with error checking, packet acknowledgements and retransmissions to achieve a reliable invisible wireless data link. Built for ease of use and rapid installation, the serial interface ensures direct connection to a microprocessor or to an RS232, while remote configuration enables post installation setup of the modem.

Contact:
Telelink Communications
PO Box 5457, North Rockhampton 4702
Tel: (07) 4934 0413 Fax: (07) 4934 0311
website: www.telelink.com.au

TOROIDAL POWER TRANSFORMERS



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Comprehensive data available

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BitScope Designs
www.bitscope.com

Vishay's new 5mm 4000mCd LED

Vishay Intertechnology has completed its ultra-bright TLCx5100 LED series with the new TLCW5100, an exceptionally bright and highly visible 5mm white LED designed to meet the demands of high-end lighting applications.

Built on high-efficiency InGaN technology, the new TLCW5100 is a clear, non-diffused LED with 0.33 chromasticity and typical luminous intensity of 4000mCd. A 9° angle of intensity and an untinted plastic lens are optimised to provide exceptional light output and visibility.

Devices in the TLCx5100 series, which also includes red, blue, yellow, and true green versions with luminous intensity as high as 20,000mCd, serve as energy-saving and more reliable alternatives to incandescent lamps in a broad range of applications including interior and exterior lighting, outdoor display panels, automotive instrumentation and front-panel indicators, and light guide designs.

Contact:
Vishay Intertechnology Asia Pte Ltd
Tel: 0011 65 6780 7812
website: vishay.com

Rackmount chassis for serial ATA drives

Intelligent Systems Australia has released a new range of its popular rackmount computer chassis. The new range provides hot swap drive bays to support the new serial ATA (SATA) hard disk drives.

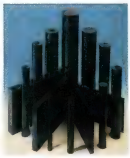
Serial ATA hard disk drives are now readily available from the major drive manufacturers and are very cost effective. They boast faster data transfer rates than ATA 100 drives and use small cables. This provides less cable clutter, promoting better air flow for cooling inside the computer chassis.

The new rackmount chassis are available in the following sizes: 1RU providing two SATA Hot Swap drive bays; 2RU providing four SATA Hot Swap drive bays; and 3RU also providing four SATA Hot Swap drive bays.

All SATA chassis are available with ATX or EPS power supplies.

Contact:
Intelligent Systems Australia
PO Box 635, Cockatoo Vic 3781
Tel: (03): 5968 0117 **Fax:** (03) 5968 0119
website: intelligentsystems.com.au

Tough new polymer



A new polymer has been introduced by Dotmar EPP that can be used as an economical alternative to costly high performance plastics in a variety of demanding high-tech applications.

Even when exposed to chemicals and high temperature environments, the new Techtron HPV PPS thermoplastic offers a multi-purpose combination of properties relative to wear resistance, load-bearing capabilities and dimensional stability.

Typical applications for the Techtron HPV PPS series of stock shapes can be found in chemical process equipment (eg, pump, valve and compressor components), industrial drying and food processing ovens, and in the electrical and electronics industries (eg, high temperature insulators and brush holders).

Manufactured of reinforced, internally lubricated linear polyphenylene sulphide resin, Techtron HPV PPS resists a wide variety of organic and inorganic chemicals.

Contact:
Dotmar EPP
2/5 Talavera Rd, North Ryde NSW 2113
Tel: (02) 9878 5544 **Fax:** (02) 9878 6366
website: www.dotmar.com.au

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How many times have you wanted to access a company's website but cannot remember their site name?

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RadioTalk puts your mobile phone through your car radio!

Radio Talk, a new product from Binoccas Promotions, is a wireless hands-free device that works with any mobile phone. It is innovative micro technology, with no wires or plug-in components and can be used anywhere at any time.

The tiny Radio Talk transmitter clips onto any mobile phone. The user then simply selects a pre-tuned frequency on their car radio and the sound is then heard through the car's speakers.

Radio Talk frees the user to talk without wires, earplugs or expensive installed devices. Its use also reduces exposure to the much publicised mobile phone radiation.

Radio Talk fits any phone and works with any radio, thereby providing simple, hands-free communication at all times, either in the car or at home or in the office.

Recommended retail price is $49.95.

Contact:
Binoccas Promotions
Tel: (07) 3852 1320
website: radiotalk.com.au

By JOHN CLARKE

A Low-Cost 50MHz Frequency Meter

Featuring a 16-character LCD readout, this compact 50MHz Frequency Meter can be either battery-operated or run from a DC plugpack supply. It's very accurate and includes auto-ranging and two different resolution modes.

FREQUENCY METERS are used in virtually all areas of electronics and are invaluable for servicing and diagnostics. Among other things, they are ideal for checking the operation of oscillators, counters and signal generators. They can also be used for servicing RF equipment or to simply provide an accurate frequency readout for a function generator.

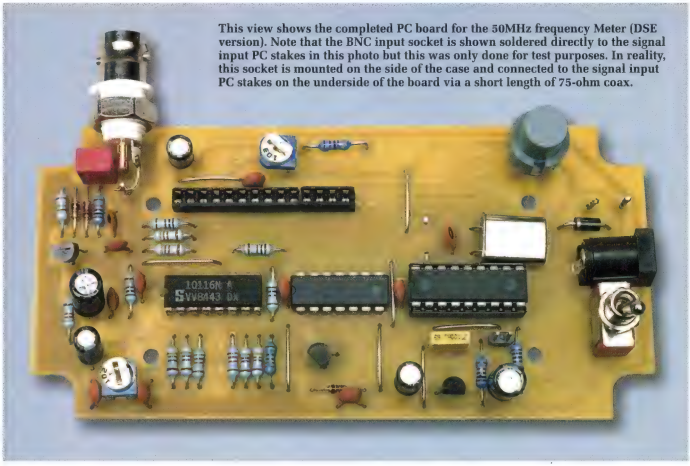
This new 50MHz Frequency Meter is autoranging and displays the frequency in either Hz, kHz or MHz. This makes the unit easy to read, as it automatically selects the correct range for any frequency between 0.1Hz and 50MHz and inserts the decimal point in the correct place for each reading.

The design is easy to build too, since it uses a programmed PIC microcontroller to do all the clever stuff. Apart from that, there's an LCD readout, a couple of low-cost ICs, two transistors, a 3-terminal regulator and a few sundry bits and pieces to complete the design.

Note that although we have specified this Frequency Meter at 50MHz maximum, most units will be capable of measuring frequencies somewhat higher than this. In fact, our prototype meter was capable of making frequency measurements to above 64MHz.

LCD readout

A feature of this unit is the use of a 2-line 16-character Liquid Crystal Display (LCD) to show the frequency



This view shows the completed PC board for the 50MHz frequency Meter (DSE version). Note that the BNC input socket is shown soldered directly to the signal input PC stakes in this photo but this was only done for test purposes. In reality, this socket is mounted on the side of the case and connected to the signal input PC stakes on the underside of the board via a short length of 75-ohm coax.

reading. This has several advantages over LED displays, including much lower current consumption. This allows the unit to be operated from batteries if required.

In addition, the LCD can show all the units without resorting to the use of separate annunciators, as would be required with a LED display.

Resolution modes

Two resolution modes are available: (1) a low-resolution mode which has fast updates and is suitable for most measurements; and (2) a high-resolution mode which can be selected when greater precision is required.

In the low-resolution mode, the resolution is 1Hz for frequencies from 1-999Hz and 10Hz for frequencies above this. The corresponding display updates time are 1s from 1-999Hz and 200ms from 1kHz-50MHz.

By contrast, the high-resolution mode provides 1Hz resolution for frequencies from 150Hz-16MHz. Above 16MHz, the resolution reverts to 10Hz. The display update time is 1s.

Below 150Hz in the high-resolution mode, the display has 0.1Hz resolution and a nominal 1s update time for frequencies above 10Hz. This 0.1Hz resolution makes the unit ideal for testing loudspeakers, where the resonance frequency needs to be accurately measured.

Note, however, that the update time takes longer than 1s for frequencies below 10Hz.

The two resolution modes are toggled from one to the other by pressing the Resolution switch. The meter then displays either "Resolution LOW" or "Resolution HIGH" to indicate which mode is currently selected. In addition, the selected resolution mode is stored in memory and is automatically selected if the meter is switched off and on again.

In the low-resolution mode, the display will show 0Hz if the frequency is below 1Hz. By contrast, in the high-resolution mode, the display will show "No Signal" for frequencies below 0.1Hz.

If the frequency is below 0.5Hz, the display will initially show an "Await Signal" indication before displaying the frequency. If there is no signal, the display will then show "No Signal" after about 16.6s.

The 0.1Hz resolution mode for frequencies below 150Hz operates in a different manner to those measurements made at 1Hz and 10Hz resolution. Obtaining 0.1Hz resolution in a conventional frequency meter normally means measuring the test frequency over a 10s period. And that means that the update time is slightly longer than 10s.

Main Features

- Compact size (130 x 67 x 44mm)
- 8-digit display (LCD)
- Automatic Hz, kHz or MHz indicator units
- Two resolution modes
- 0.1Hz resolution up to 150Hz
- 1Hz resolution maximum up to 16MHz
- 10Hz resolution above 16MHz
- Battery or DC plugpack supply

Parts List

1 PC board, code 04110031 for Dick Smith Electronics version; or code 04110032 for Altronics version; or 04110033 for Jaycar version – 121 x 61mm
1 plastic case, 130 x 67 x 44mm
1 front panel label to suit version, 125 x 64mm
1 LCD module (DSE Cat. Z 4170, Altronics Cat. Z 7000A or Jaycar Cat QP 5515)
1 SPST toggle switch (S1)
1 pushbutton momentary contact switch (S2)
1 panel-mount BNC socket
1 low-drift 4MHz crystal (Hy-Q HC49/U 4000.00kHz GG03E) (X1)
1 PC-mount 2.5mm DC socket
1 18-pin dual-wipe contact DIP socket (for IC3)
1 28-pin dual-wipe contact DIP socket (for DSE & Altronics LCD modules; see text); OR
1 14-pin dual-wipe contact DIP socket (for Jaycar LCD module)
4 M3 x 10mm countersunk screws
4 M3 nuts
4 M3 x 6mm cheesehead screws
4 M3 x 10mm tapped Nylon spacers
10 PC stakes
1 300mm length of 0.7mm tinned copper wire
1 60mm length of 75Ω coax
1 1kΩ horizontal trimpot (code 102) (VR1)
1 10kΩ horizontal trimpot (code 103) (VR2)

Semiconductors

1 MC10116N triple ECL differential line receiver (IC1)
1 74HC132 quad Schmitt trigger (IC2)
1 PIC16F84-04/P microcontroller programmed with freqency.hex (IC3)
1 78L05 regulator (REG1)
1 2N5485 N-channel VHF JFET (Q1)
1 BF450 PNP transistor (Q2)
3 BAW62 diodes (D1-D3)
1 1N4004 1A diode (D4)

Capacitors

2 100µF 16V PC electrolytic
3 10µF 16V PC electrolytic
1 470nF MKT polyester
1 100nF MKT polyester
8 10nF ceramic
1 470pF ceramic
1 33pF NP0 ceramic
1 22pF ceramic
1 10-60pF trimmer (VC1)

Resistors (1%, 0.25W)

1 910kΩ	2 2.2kΩ
1 100kΩ	7 470Ω
1 47kΩ	1 330Ω
2 10kΩ	4 100Ω

This 10s update time is a very long time to wait if you are adjusting a signal generator to a precise frequency. However, in this frequency meter, the display update period is 1s for frequencies above 10.0Hz, increasing gradually to 10s for frequencies down to 0.1Hz. So for normal audio frequencies, the display will update at 1s intervals. Just how this is achieved is explained below, when we describe the block diagrams for the unit.

Presentation

As shown in the photos, the 50MHz Frequency Meter is presented as a "standalone" unit that's housed in a small plastic case. As mentioned, it can be powered using either a 9-12V DC plugpack or a 9V battery.

There are just two controls on the front panel: an on/off switch and the "Resolution" pushbutton. In addition, a DC input socket is mounted at one end of the box, while the signal input connects to a panel-mounted BNC socket on one side.

Alternatively, the unit could be added to an existing piece of equipment to provide accurate frequency readout. Its low current requirements mean that it can usually be connected to an existing supply rail inside the equipment.

Block diagrams

Fig.1 shows the general arrangement of the frequency meter. It's based mainly on the microcontroller (IC3).

In operation, the input signal is processed and applied directly to a divide-by-256 prescaler that's internal to IC3. The divided signal then clocks timer TMR0 which counts up to 256 before clocking Register A.

Register A is an 8-bit register which counts up to 256 before returning to zero. Combining all three counters (the prescaler, TMR0 and register A) allows the circuit to count up to 24 bits, or a total of 16,777,216 counts.

By counting over a 1s period, it follows that the unit can make readings up to about 16.7MHz. However, if the frequency is counted over a 100ms period, the theoretical maximum that can be measured is just over 167MHz.

As shown in Fig.1, the input signal is first boosted using an amplifier to a level sufficient to drive gating stage IC2a. This, in turn, drives clocking stage IC2b which is controlled by IC3's RA3 output. Normally, IC2b allows the signal to pass through to the prescaler at IC3's RA4 input.

IC3's RB2 output controls gating stage IC2a so that signal passes through for either a 100ms period or a 1s period. During the selected period, the signal frequency is counted using the prescaler, timer TMR0 and register A. Initially, the prescaler, the timer and register A are all cleared to 0 and the RB2 output is then set to allow the input signal to pass through to the prescaler for the gating period (ie, for 100ms or 1s).

During this period, the prescaler counts the incoming signal applied to RA4. Each time its count overflows from 255 to 0, it automatically clocks timer TMR0 by one count. Similarly, when ever the timer output overflows from 255 to 0, it sets a Timer Overflow Interrupt Flag (TOIF) which in turn clocks Register A.

At the end of the gating period, IC3's RB2 output is cleared, thus stopping any further signal from passing through to the prescaler. The value of the count in TMR0 is now transferred to Register B. Unfortunately, the value in the prescaler cannot be directly read by IC3 and so we need to derive the value.

This is done by first presetting register C with a count of 255. That done, the RA3 output is taken low to clock the prescaler and timer TMR0 checked to see if it's count has changed. If TMR0 hasn't changed, the prescaler is clocked again with RA3.

During this process, register C is decreased by 1 each time the prescaler

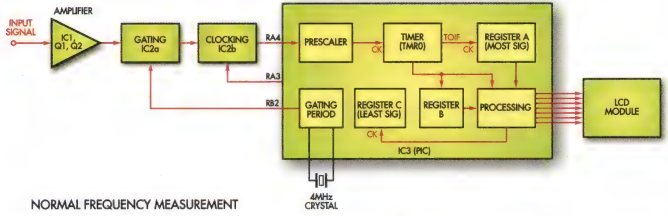


Fig.1: the block diagram of the 50MHz Frequency Meter for "normal" frequency measurements. The incoming signal is first amplified, then fed through a gating circuit to clocking stage IC2b. This then drives a divide-by-256 prescaler inside microcontroller IC3. (ie, at the RA4 input).

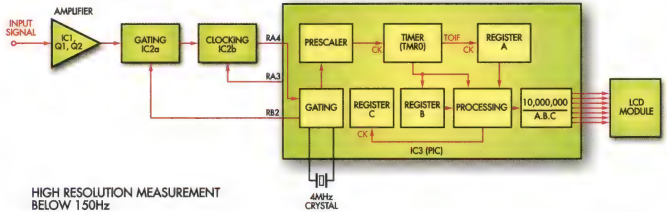


Fig.2: this is the alternative configuration for making high-resolution (ie, to 0.1Hz) measurements below 150Hz. In this case, the input signal is applied to the RA4 input as before. However, the prescaler is no longer clocked by the RA4 input but by an internal 1MHz clock instead.

is clocked. The process continues, with RA3 clocking the prescaler until timer TMR0 changes by one count. When this happens, it indicates that the prescaler has reached its maximum count. The value in Register C will now be the value that was in the prescaler at the end of the counting period.

The processing block now reads the values in registers A, B and C. Based on this information, it then decides where to place the decimal point and whether to show Hz, kHz or MHz. The required value is then written to the LCD via the data and control lines (RB4-RB7 and (RA0-RA2).

Alternative configuration

If the input signal frequency is greater than 16MHz and the gating period is 1s, register A will initially have overflowed. In this case, the gating period is automatically changed to 100ms. Alternatively, if the high-resolution mode is selected and the frequency is below 150Hz, the frequency meter changes its configuration to that shown in Fig.2.

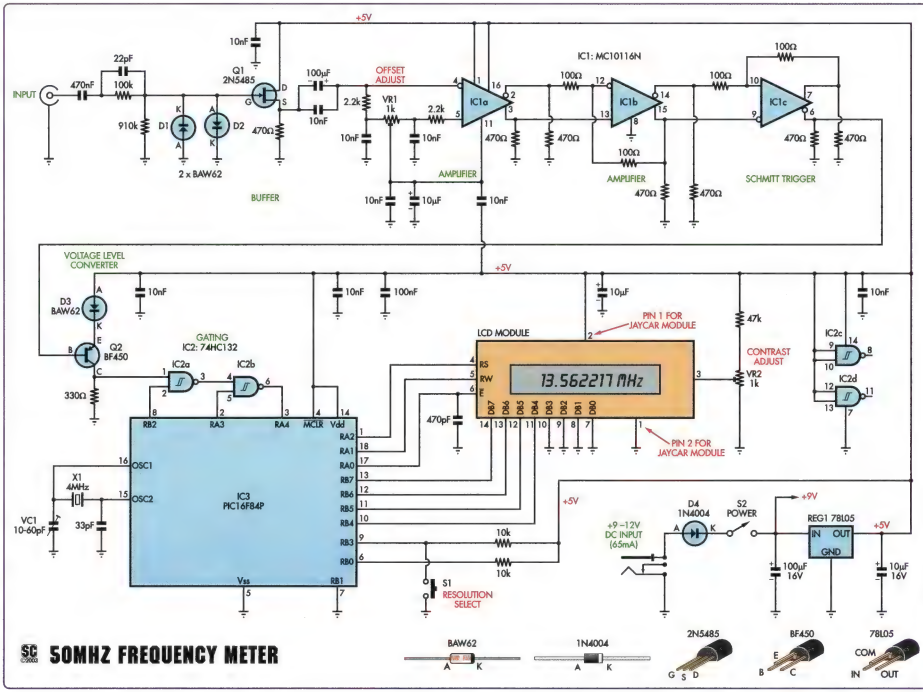
In this case, the input signal is applied to the RA4 input as before. However, the prescaler is no longer clocked by the RA4 input but by an internal 1MHz clock instead.

Basically, what happens is that the RA4 input is monitored for a change in state – ie, from a low voltage to a high voltage – which indicates a signal at the input. When this happens, the prescaler is cleared and begins counting the 1MHz internal clock signal. The overflows from the prescaler and timer TMR0 are carried to Register A as before.

Counting continues until the input signal goes low and then high again, at which point counting stops. If the counting causes register A to overflow, then the display will show no signal (this will happen after 16.7s if the signal does not go low and high again). Conversely, if the counting is within range, the prescaler value is determined by clocking IC2b using the RA3 output as before.

From this, it follows that if the input frequency is 1Hz (ie, a 1s period), the value in the A, B and C registers will be 1,000,000. That's because the prescaler is clocked at 1MHz for 1s. Similarly, the count will be 100,000 for a 10Hz signal and 10,000 for a 100Hz input signal.

Finally, the value in the registers is divided into 10,000,000 and the decimal point placed immediately to the left of the righthand digit. This gives a direct readout in Hz with 0.1Hz resolution on the LCD.



SOMHZ FREQUENCY METER

Note, however, that this technique can not be used for measuring very high frequencies. That's because the value in the counter becomes smaller as the frequency increases and so we begin to lose accuracy. For example, at 500Hz, the counted value would be 2000 and at 500.1Hz the counted value would be 1999. The result of the division of 1999 into 10,000,000 would be 500.2 instead of the 500.1 required.

The 0.1Hz resolution has therefore been restricted to a maximum of 150Hz to ensure accuracy of the calculation.

Circuit details

Refer now to Fig.3 for the full circuit details. As shown, the input signal is AC-coupled to the unit via a 470nF capacitor to remove any DC component. This signal is then clipped to about 0.6V peak-to-peak using diodes D1 & D2, with current limiting provided by the 100kΩ series resistor. The 22pF capacitor across the 100kΩ resistor compensates for the capacitive load of the diodes.

From there, the signal is fed to the gate of Q1, a 2N5485 JFET. This transistor provides a high input impedance, which is necessary to ensure a wide frequency response.

Q1 is self-biased using a 910kΩ resistor from gate to ground and a 470Ω source resistor. It operates with a voltage gain of about 0.7, which means that the signal is slightly attenuated at the source. This loss is more than compensated for in the following amplifier stages.

Next, the signal is AC-coupled to pin 4 of amplifier stage IC1a via a 100μF electrolytic capacitor and a parallel 10nF capacitor. The 100μF capacitor is sufficiently large to allow for a low frequency response of less than 1Hz. However, this capacitor loses its effectiveness at higher frequencies due to its high internal inductance and the signal is coupled via the 10nF capacitor instead.

IC1a is one of three differential line receivers in a single MC10116N IC package. It's biased via the DC output at pin 11 and this is decoupled using a 10μF electrolytic capacitor and a paralleled 10nF ceramic capacitor. The voltage is then applied to the wiper of trimpot VR1 (Offset Adjust) and this allows adjustment of the input bias voltage.

In operation, IC1a is run open loop (ie, without feedback) so that it provides as much gain as possible. Even so, it only operates with a voltage gain of about seven times. It's differential output signals appear at pins 2 & 3 – ie, one output is opposite in phase to the other. These outputs are in turn applied to the differential inputs (pins 12 & 13) of IC1b.

Note that the differential outputs have 470Ω pulldown resistors, as they are open emitters. In fact, the MC10116 IC is an emitter-coupled logic (ECL) device.

Unlike IC1a, IC1b has negative feedback and this is provided by the two associated 100Ω resistors. This reduces the gain of this stage to just under two.

The third stage using IC1c differs in that it employs positive feedback and so it functions as a Schmitt trigger rather than as an amplifier. Its hysteresis is around 450mV which means that the signal swing on its differential inputs must be greater than this in order for this stage to provide an output.

In operation, the output swing at pins 6 & 7 is from 4.3V when high to 3.4V when low. This needs to be level-shifted to provide for normal CMOS input levels to the gating circuit (IC2a) and this is done using PNP transistor Q2.

It works like this: when pin 6 is high at 4.3V, Q2's base is also at 4.3V, which is just 0.7V below the +5V supply rail. However, Q2 must have a base voltage that's at least 1.2V below the +5V rail in order to switch on – ie, to overcome the 0.6V "diode-drop" across D3 plus a 0.6V base-emitter voltage. As a result, when pin 6 if IC1c is high, Q2 is off and the 330Ω resistor at Q2's collector holds the output low.

Conversely, when pin 6 of IC1c goes low (3.4V), transistor Q2 turns on and pulls pin 1 of IC2a high.

IC2a is a Schmitt NAND gate. It inverts the signal on its pin 1 input when pin 2 is held at +5V by IC3's RB2 output (ie, the signal passes through to the pin 3 output but is inverted). Conversely, when RB2 is at 0V, IC2a's pin 3 output remains high and the input signal is blocked.

So, in summary, the signal is allowed through to IC2b when RB2 is high and is blocked when RB2 is low, as described previously.

IC2b normally has its pin 5 input held high via IC3's RA3 output, so that the signal from IC2a is again inverted at pin 6. When RB2 is brought low, pin 3 of IC2a remains high and so pin 4 of IC2b is also high. This allows RA3 to clock the RA4 input via IC2b.

Driving the LCD

IC3's RA0-RA2 outputs drive the control inputs to the LCD module and select the line and the position of the character to be displayed. Similarly, RB4-RB7 drive the data inputs (DB4-DB7) on the LCD module. A 470pF

Specifications

Input sensitivity: Typically less than 20mV rms from 1Hz to 100kHz rising to 50mV at 20MHz and 85mV at 50MHz.

Input Impedance: 1.1MΩ in parallel with about 10pF

Frequency range: 0.1Hz to 50MHz

Untrimmed accuracy: ±20ppm equivalent to 1000Hz at 50MHz

Trimmed accuracy: ±10ppm from -20°C to 70°C

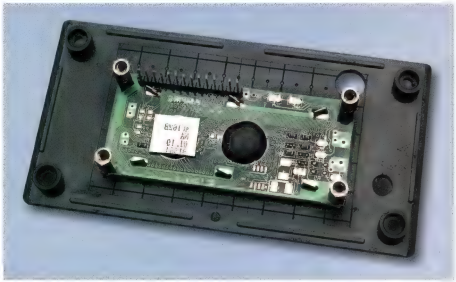
Resolution: High Resolution Mode – 0.1Hz from 0.1-150Hz; 1Hz from 150Hz-16MHz; and 10Hz from 16-50MHz. Low Resolution Mode –1Hz from 1-999Hz; 10Hz from 1kHz-50MHz

Update time (approx.): 200ms for 10Hz resolution; 1s for 1Hz resolution; 1s for 0.1Hz resolution down to 10Hz, increasing to 10s at 0.1Hz

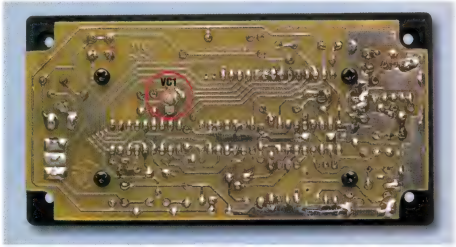
Display Units: Hz from 0.1-999Hz; kHz from 1-999.999kHz; MHz from 1-50MHz

Current consumption: 65mA with 9-12V input

Fig.3 (left): the circuit is based on microcontroller IC3. This processes the signals from the preceding amplifier stages and drives the LCD. Power comes either from a 9-12V DC plugpack or from a 9V battery.



The LCD module is secured to the lid of the case using four M3 x 6mm cheesehead screws, four M3 nuts and four M3 x 10mm tapped Nylon spacers.



The PC board is secured by plugging it into the matching header pins on the LCD module and installing four screws to fasten it to the spacers. Note the mounting method for VC1 (circled in red).

capacitor on the E-bar (enable control line) is included to slow down the rise and fall times of the square wave from IC3, which are nominally too fast for the LCD module to handle – particularly when the ambient temperature is well below 25°C.

A 4MHz crystal connected between pins 15 & 16 of IC3 provides the clock signals for IC3. The recommended crystal has low drift but a standard 4MHz crystal could be used if accuracy is not critical. The capacitors at pins 15 & 16 provide the necessary loading for the crystal so that runs at the correct frequency, while VC1 also allows the clock frequency to be "tweaked" slightly to provide calibration.

Power supply

Power for the circuit is derived from either a 9-12V DC plugpack or a 9V battery (but not both). Diode D4 protects the circuit against reverse polarity protection when using a plugpack supply, while regulator REG1 provides a +5V supply rail to power the circuit.

If a 9V battery is used, it connects to the cathode side of D4; ie, it bypasses the reverse polarity protection. This means that D4 can be left out of circuit (along with the DC socket) if the unit is to be battery powered.

Construction

The SILICON CHIP 50MHz Frequency Meter can be made in one of three versions, depending on where you buy the kit. That's because the LCD modules available from Dick Smith Electronics (DSE), Altronics and Jaycar are all different and so a different PC board has been designed to suit each module. These boards are coded 04108031 (DSE), 04108032 (Altronics) and 04108033 (Jaycar).

Each LCD plugs directly into its intended PC board, which means that there are no external wiring connections except to the BNC input socket. And in case you are wondering, there are no performance differences between the three versions.

The unit is housed in a plastic case measuring 130 x 67 x 44mm, with the LCD module protruding through a cutout in the front panel. The Dick Smith version has the power switch on the righthand side and the signal

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	910kΩ	white brown yellow brown	white brown black orange brown
❑	1	100kΩ	brown black yellow brown	brown black black orange brown
❑	1	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	2	10kΩ	brown black orange brown	brown black black red brown
❑	2	2.2kΩ	red red red brown	red red black brown brown
❑	7	470Ω	yellow violet brown brown	yellow violet black black brown
❑	1	330Ω	orange orange brown brown	orange orange black black brown
❑	4	100Ω	brown black brown brown	brown black black black brown

Table 2: Capacitor Codes			
Value	µF Code	EIA Code	IEC Code
470nF	0.47µF	474	470n
100nF	0.1µF	104	100n
10nF	0.01µF	103	10n
470pF	-	471	470p
33pF	-	33	33p
22pF	-	22	22p

input applied to the socket at the top left of the box. By contrast, both the Altronics and the Jaycar versions have the power switch at the top left, while the input socket is mounted on the lower right of the box.

This difference comes about because the display readout for the DSE LCD module is upside down compared to the other two modules in relation to the input terminals. The unit shown in the photos is for the DSE version but both the Altronics and Jaycar modules were fully tested.

Fig.4 shows the PC board layout for each of the three versions. Begin by checking that you have the correct PC board for the LCD module you are using. That done, check the mounting holes for the LCD module against those on the PC board (the holes must be 3mm in diameter). Check also that holes are large enough to mount switch S2 and the DC input socket.

Next, install all the wire links and resistors, using the accompanying resistor colour code table as a guide to selecting each value. It's also a good idea to check the resistors with a digital multimeter just to make sure.

IC1 and IC2 can go in next, taking care to ensure that they are correctly oriented. That done, install a socket for IC3 but don't install the microcontroller just yet.

The diodes and capacitors can now all be installed, followed by REG1 and transistors Q1 & Q2. Note that the 100µF and 10µF capacitors in the Altronics version must be installed with their bodies parallel to the PC board, so that they don't later foul the LCD module. It's just a matter of bending their leads at right angles before installing them on the board.

Similarly, the top of transistor Q2 must be no higher than 10mm above the PC board to prevent it from interfering with the LCD module (all versions).

The next step is to install the socket

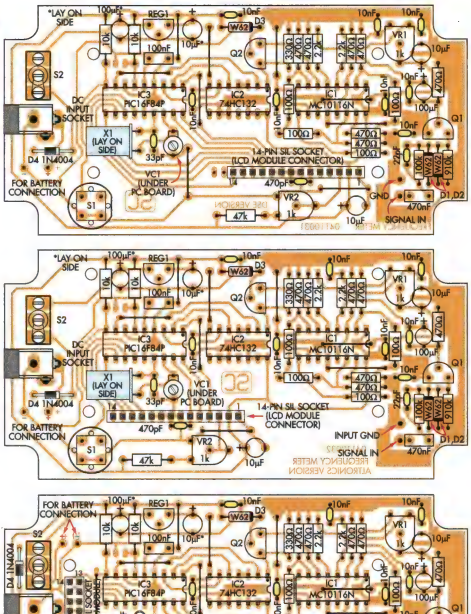


Fig.4: three different PC boards have been designed to suit the different LCD modules that are available from DSE, Altronics and Jaycar. Just follow the parts layout that's applicable to your version.

for the LCD module. Both the DSE and Altronics versions use a 28-pin DIL IC socket which is cut in half to obtain a 14-way strip socket which is then soldered in place. By contrast, the Jaycar version uses a 14-pin IC socket which is cut into two 7-way strips which are then installed side-by-side.

Once the sockets are in, install PC stakes for the "+" and "-" supply connections (near D4) and for the signal input and GND connections. These PC stakes should all be installed from the copper side of the board.

PC stakes are also used to mount switch S1. These should be trimmed so that when the switch is mounted, its top face is 20mm above the top surface of the PC board. Be sure to

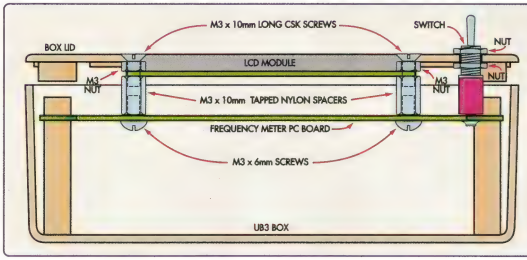


Fig.5: this diagram shows how the unit is installed inside the case. Be sure to use Nylon spacers where indicated,

orient S1 with its flat section facing towards the right, as shown in Fig.4.

The remaining parts can now be installed on the board. These parts include switch S2, the DC socket, trimpots VR1 & VR2, crystal X1 and trimmer capacitor VC1.

Note that VC1 is mounted on the underside of the PC board, so that it can be adjusted without having to remove the LCD module.

Front panel

The front panel (ie, the case lid) must be drilled and a cutout made to accommodate the two switches and the display. However, if you have purchased a kit, then you probably won't have to worry about this.

If you're preparing the case yourself, you can use one of the front panel artworks as a drilling template (see Figs.6 & 7). You can make the display cutout by first drilling a series of holes around the inside perimeter of the rectangle, then knocking out the centre piece and filing the job to a smooth finish.

It will also be necessary to drill the mounting holes for the LCD module. Note that these should be countersunk so that the intended screws sit flush with the surface of the lid – see Fig.5. That done, the adhesive label can be attached to the panel and the cutouts made using a utility knife

Kit versions will probably be supplied with screen-printed labelling. In that case, countersunk screws will no longer be necessary.

Checkout time

Now for an initial smoke test – ie, before IC3 or the LCD are plugged in.

First, apply power and check that there is +5V on pin 16 of IC1, pin 14 of IC2 and pins 4 & 14 of IC3. If this is correct, disconnect power and install IC3 in its socket, taking care to ensure it goes in the right way around. That done, plug the LCD module into its matching socket and temporarily fit a couple of 10mm tapped Nylon spacers to support it on the PC board.

Next, reapply the power again and check that the display shows either 1Hz or 0Hz. If not, adjust VR1 so that the display shows 0Hz when the signal input terminals are shorted. VR2 can then be adjust for best display contrast.

Now press the Resolution switch – the display should show "Resolution HIGH". It should then show "Await Signal" when the switch is released. If the switch is then pressed again, the display should show "Resolution LOW".

Final assembly

The Frequency Meter can now be installed in its case.

Fig.5 shows the assembly details. As shown the LCD module, is secured to the case lid using four M3 x 10mm CSK screws, four M3 nuts (used as spacers) and four 10mm-long tapped Nylon spacers. The PC board is then secured to the bottom ends of the four spacers.

You will have to drill a 9mm-diameter hole in one side of the box to provide access to the DC socket if you are powering the unit from a plugpack. This hole should be positioned midway along one side and about 6mm down from the top edge of the case.

Conversely, if the unit is to be battery powered, you will need to solder a battery clip lead to the supply PC stakes on the underside of the board. The battery can be secured to the bottom of the case by mounting it in a suitable holder. Alternatively, you could dispense with the holder and simply wrap the battery in some insulating material and wedge it between the PC board and the bottom of the case.

The BNC input socket is mounted on one side of the case towards the base and wired using 75Ω cable to the two signal input PC stakes on the underside of the PC board.

Calibration

The completed 50MHz Frequency Meter can be calibrated against the 15.625kHz line oscillator frequency in a colour TV set. Fortunately, you don't need to remove the back of the set to do this. Instead, all you have to do is connect a long insulated wire lead to the input socket and dangle it near the back of the TV set.

It's then just a matter or adjusting VC1 so that the meter reads 15.625kHz when the resolution is set to "High" mode.

Note: the TV must be showing a PAL program, not NTSC (15.750kHz).

If there is insufficient adjustment on VC1 to allow calibration, the 33pF capacitor at pin 15 of IC3 can be altered. Use a smaller value if the frequency reading is too high and a larger value if the frequency reading is too low.

Usually, the next value up or down from 33pF will be sufficient – ie, use either 27pF or 39pF.

If you require greater accuracy, the

unit can be calibrated against the standard 4.43MHz colour burst frequency that's transmitted with TV signals. The best place to access this frequency is right at the colour burst crystal inside a colour TV set. This crystal will usually operate at 8.8672375MHz (ie, twice the colour burst frequency), although some sets use a 4.43361875MHz crystal.

Be warned though: the inside of a colour TV set is dangerous, so don't attempt to do this unless you are an experienced technician. There are lots of high voltages floating around inside a colour TV set and you could easily electrocute yourself if you don't know what you are doing.

In particular, note that much of the circuitry in a switchmode power supply circuit (as used in virtually all late-model TV sets) operates at mains potential (ie, many of the parts operate at 240VAC). In addition, the line output stages in some TV sets also operate at mains potential – and that's in addition to the lethal EHT voltages that are always present in such stages.

Note too that some TV sets (particularly older European models) even have a "live" chassis, in which all the circuitry (including the chassis itself) operates at mains potential. Usually, there will be a label on the back of the set advising of this but don't take it for granted. Don't even think of messing about with this type of set.

In short, don't attempt the following calibration procedure unless you are experienced and know exactly what you are doing.

OK, assuming that you know what you are doing (and the set has a grounded chassis), you will need to make up an insulated probe with a 10MΩ resistor in series with the input plus a ground lead. This probe can then be connected to one side of the colour burst crystal and VC1 adjusted so that the meter reads either 8.867237MHz or 4.433618MHz (resolution set to high mode).

Make sure that the probe has no affect on the colour on the TV screen when it is connected to the colour burst crystal. If it does, it means that the probe is loading the crystal and altering its frequency. In that case, try connecting the probe to the other terminal of the crystal.

That's it – your new 50MHz frequency Meter is now calibrated and ready for action. **SC**

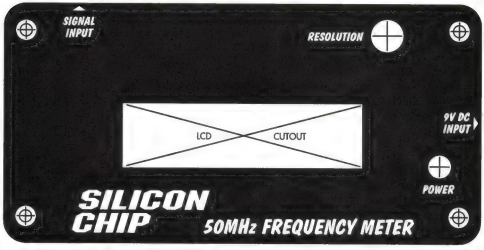


Fig.6: this is the full-size front-panel artwork for the DSE version.

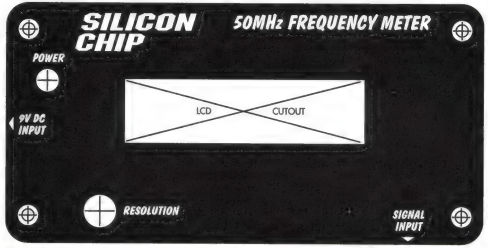


Fig.7: the Altronics and Jaycar versions both use this front panel artwork.

This photo clearly shows the location of the access hole for the DC input socket for the DSE version. It's located on the opposite side of the case for the Altronics and Jaycar versions.

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Remote control your PC!

NEW

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K 2755

(SC Aug '03) Connects to your serial port and provides remote control of Winamp and WinDVD software as well as a host of other remote PC automation abilities.

BONUS DEAL! For just $10 extra, pick up an A 1013 remote control to suit. Valued at $36

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Great way to clean up precious jewellery in a FLASH! , without nasty solvents or abrasives!

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This professional DMM is ideal for R&D, service work and scientific applications. ***A long time tried and proven meter!***

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S 5311

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Features a handy macro key!

$55

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A 1008

Move your data FAST!

Great for data backups or moving your data from home to office. Allows you to switch hard drives quickly and easily.

Features: Power & HDD activity LED's, fan cooling. Also suits ZIPs, LS-120 etc.

$26.95

D 5500

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SAVE $75!

Fantastic for schools, theatre groups, houses of worship etc. With 5 channels that can accept up to 9 input sources. Also features, 3 band graphic EQ, channel volumes, crossfader and analog VU meters.

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A 2551

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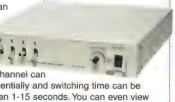
This switcher can connect up to 4 cameras with audio to your security monitor. Each channel can be viewed sequentially and switching time can be adjusted between 1-15 seconds. You can even view and record simultaneously!



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S 9080S

Catch Thieves Red Handed!

DON'T LET THIEVES AND VANDALS HIT YOU IN THE HIP POCKET! S 9095 is a 4 channel B&W switching unit with a 12 inch screen. S 9093 is a single channel B&W unit with a 10" screen.

S 9093

S 9095

$169 Normally $199 S 9093

$255 Normally $299 S 9095

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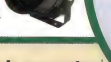

$20

Normally $26.80

S 6130

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6 Sector Alarm

NOW WITH DIALLER!

At last a quality professional alarm system at an affordable price! Install it yourself and save a fortune! This 6 zone system is ideal for most homes. It is supplied in 2 parts and can be fully installed and programmed by **YOU** in just hours. Its that easy! **The new dialler function can ring up to 4 different numbers anywhere in the world when your alarm triggers!** Supplied with controller lock box and entry way keypad.

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REMEMBER! Most insurance companies offer premium reductions for homes with alarms!

BONUS OFFER

Every S 5260 includes a free S 5075 backup battery and M 9325 Plugpack (Valued at $49.10).

Charge your SLA's

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$19.95

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M 8250

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Fully adjustable with LCD meters for precision adjustments. Suitable for both the professional or enthusiast.

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SAVE MONEY WITH HIGH POWER RECHARGEABLES!

MASSIVE 2000mAh capacity!

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A 2546

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No need for any messy cabling, watch your favourite DVD in bed or monitor your kids by the pool (using a camera with audio). The unit sends vision and sound to another location whilst the infra red repeater allows you to control your devices remotely. Ideal for security or home theatre/hi-fi use.

$229
S 9360

***BONUS OFFER!* Purchase the S 9360 and receive the A 1008 remote control (valued at $55) for FREE!**

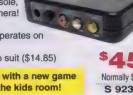
Add big bass to your movies!

Get some OOMPH into your movies! A subwoofer can add mindblowing realism to your home theatre system. Features a big 10 inch 180W driver with powerful built in amplifier. Stunning low frequency response. Adjustable crossover and level control built in. Fantastic value!

Save $60!

$369
Normally $429
C 5200

Get some use out of that old telly!



The perfect solution if you've got an old television with a new gaming console, even a security camera! With built in 15dB antenna booster. Operates on VHF channel 3.
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$45
Normally $59
S 9233

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39¢/m*
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W 2130

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Don't waste your cash on buying ali new USB devices for your PC when you can take advantage of USB connectivity for a small outlay. This nifty device lets you connect an older serial device to your computers USB port.

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Normally $62
D 2340

Digital Hygrometer & Thermometer

Simultaneously shows temperature as well as humidity. ***Features:***
• Min/Max memory
• Suitable for desk- or wall mounting
• Wide temp. range

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A 0150

Monitor environmental conditions in greenhouses, wine cellars, computer rooms, office air con, aquariums etc!

KITS KITS KITS!

Portable PIC Programmer Kit

(SC Sept. '03) Finally a portable solution to PIC programming. This battery powered unit can is suitable for programming: 8 & 18 pin PIC16F and 12F, 28 and 40 pin 16F87X series, 24CXX EEPROMS.

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K 9505

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$59.95
K 4375

Get the most from your digital camera!

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K 2750S

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05-03

Long-range 16-channel remote control system

Based on pre-built UHF transmitter and receiver modules, this versatile 16-channel remote control is very easy to build and requires no alignment. It has a range of up to 1.5km and you can program it to function just the way you want.

By JEFF MONEGAL

REMOTE CONTROL SYSTEMS are hardly new but before you write this one off as just another variation, take a look at the features panel. It's got a lot more features than other standard "run of the mill" remote control projects.

Among other things, these features include a 4-digit combination lock to prevent unauthorised use, extra long range (up to 1.5km), 16 independent channels and programmable channel functions. There are also two modes of operation: Mode 1 and Mode 2.

Two pre-built UHF modules make this unit really easy to build. The transmitter module is designated the TX434 and uses a SAW resonator to lock the transmission frequency to 433.92MHz.

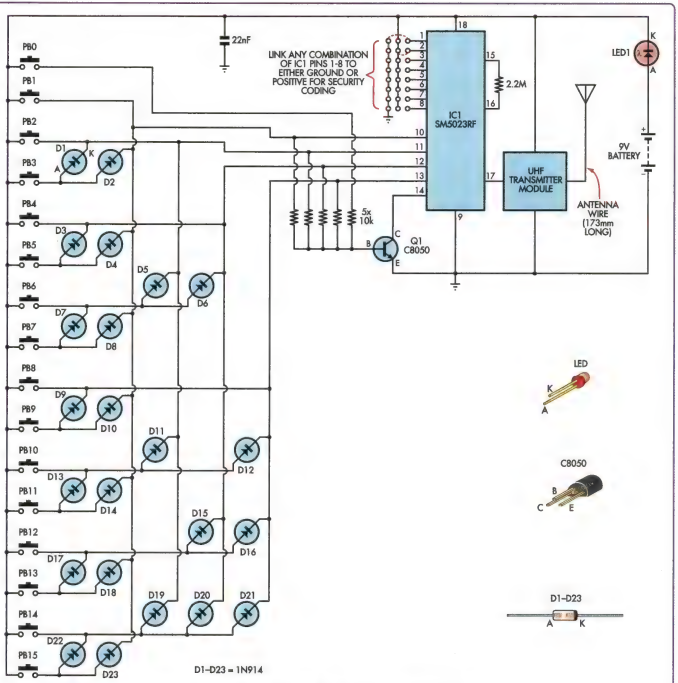
This module is truly tiny, measuring just 20mm long x 8mm wide. It has a data rate of 1200pbs (maximum), a frequency tolerance of 175kHz and operates from a 3-9V DC supply. It also has seven external connections and is installed "surface-mount" style on the back of the transmitter PC board.

At the other end of the link is the complementary RX434 UHF receiver module. This is a full superheterodyne UHF receiver that measures just 44 x 15mm. It is crystal-locked to 433.92MHz, has a sensitivity of 115dBm, operates from a 5V DC supply and has eight external connections (four at either end) which are brought out to pin headers. It is installed directly on the receiver PC board.

Both UHF modules are supplied pre-aligned, which means that you don't have to make any adjustments after assembly.

Channel functions

Because we've got 16 channels to play with, we've divided them up into several groups and given them different functions for Mode 1 opera-



SC 16-CHANNEL UHF REMOTE CONTROL TRANSMITTER

Fig.1: the transmitter uses trinary encoder IC1 to feed a coded data stream to a 433MHz transmitter module. The code depends on which pins (10-14) of IC1 are pulled high by switches PB0-PB16 and the D1-D23 diode matrix.

ion. What's more, you can program the channels at will thanks to a PIC microcontroller that's buried in the receiver circuit.

OK, let's take a closer look at these channel groupings:

Channels 0-5: these channels can be set up for either momentary or toggle operation. When the unit is powered up for the first time, the default for all channels is toggle mode. Pressing any of the 0-5 buttons will then change the output state of the associated channel.

To change modes, the operator simply holds the required channel button down for more than two seconds (2s), after which a beep will be heard and the button can be released. If the channel was in toggle mode, it will now be in momentary mode and vice versa. It's as easy as that!

Pressing the button again for 2s will swap the modes back again. All changes to the various modes are stored in an EEPROM, so if power is lost and then restored, the channels will all come up with all modes set as last programmed.

Note that when a channel is set to

Main Features

- 16 channels – see text for channel functions.
- Up to 1.5km range or further in some cases.
- 4-digit combination lock with fully reprogrammable code.
- Two modes of operation – full featured or standard toggle/momentary.
- Back up fail-safe code in case user code is lost or forgotten.
- Fail-safe code is different for each kit sold.
- Program boots up in "Locked" mode – system unusable if stolen.
- All codes, times and modes stored in EEPROM and reloaded at power on.

momentary mode, its output line goes high for 1s and then low again when the corresponding transmitter button is pressed and released.

Channels 6 & 7: these are non-programmable channels where the outputs go high when their buttons are pressed and remain high while ever the buttons are pressed. These channels could be useful for dimming lights or controlling music volume via suitable interface circuitry.

Channels 8-11: these channels all have programmable timers attached. Channels 8 & 9 are programmable from 1-255s. Their outputs go high when activated, then go low again 1-255s later (ie, after the programmed interval). During the last 10 seconds, an inbuilt speaker in the receiver "beeps" every second.

Channels 10 & 11 work the same way but their delay times are programmable from 1-255 minutes. Once activated, the speaker "beeps" every minute on channel 10, while channel 11 is totally silent (eg, so that it could control a bedroom fan via a suiable interface) except when first activated.

Channels 12 & 13: the outputs of these channels go high when their respective buttons are pressed and remain high until an external event pulls the inputs to these channels low. These channels can also be turned off by simply pressing their respective buttons on the keypad again.

Channels 14 & 15: these channels are programmable from 1-255 minutes. When their buttons are pressed, their outputs remain low but subsequently go high for 1s at the end of their programmed times. Pressing a channel button during the time period simply cancels the end result and the output remains low.

Mode 2

In Mode 2, as selected by an onboard link, all channels are the same as channels 0-5 above – ie, all channels are have either momentary or toggle operation. Each individual channel output changes state with each press of its corresponding button on the transmitter.

Note, however, that the transmitter button has to first be released before the operation takes place. In other words, to change a channel, you must first press its transmitter button and then release it again. The reason for this will be explained later. As before, a channel output goes high for 1s (when the button is released) and then low again when configured for momentary operation.

Stopping unauthorised use

A 4-digit combination lock is included so that each time the system is turned on, it comes up in "locked" mode. This means that unless you enter this user code (to unlock the receiver), the unit cannot be used.

But what happens if you forget your user code? In that case, the system also has a fail-safe code which, when activated, reprograms the user code to the default of 10-10-10-10. When this is done, the user should immediately program another 4-digit user code into the receiver.

The failsafe code is different for every unit that's sold. It is supplied with the kit and should be kept secret by the owner.

How it works

Fig.1 shows the circuit details for the 16-Channel UHF Remote Control Transmitter. Apart from the UHF transmitter module, the only other component of any real note is the SM5023RF trinary encoder (IC1). In addition, there are 16 pushbutton switches, an associated diode matrix (D1-D23), a transistor (Q1), five resistors and a LED.

Trinary encoder IC1 has eight coding inputs which can either be individually tied high, low or left open circuit (O/C) to give a unique security code. This gives one of 6561 possible combinations but it's really a bit more complicated than that, as we shall see.

In order for the receiver to acknowledge the transmitter, its trinary decoder (IC2) must have the same connections as the encoder (IC1) – ie, the corresponding pins on the encoder (IC1) and the decoder (IC1 on Fig.2) must be connected in the same way (either high, low or open circuit).

OK, let's take a closer look at the transmitter circuit. There are 16 pushbutton switches (PB0-PB16) and when any of these is pressed, one or more of the inputs to IC1 (either pin 10, 11, 12 or 13) is pulled high – either directly or via two or more of the diodes in the switch matrix. The exception here is PB0 which turns on transistor Q1 via a 10kΩ resistor.

As with pins 1-8 of IC1, pins 10-13 also function as coding inputs. So when a button is pressed, its corresponding coding inputs are set to logic 1 and the code sequence from IC1 is altered.

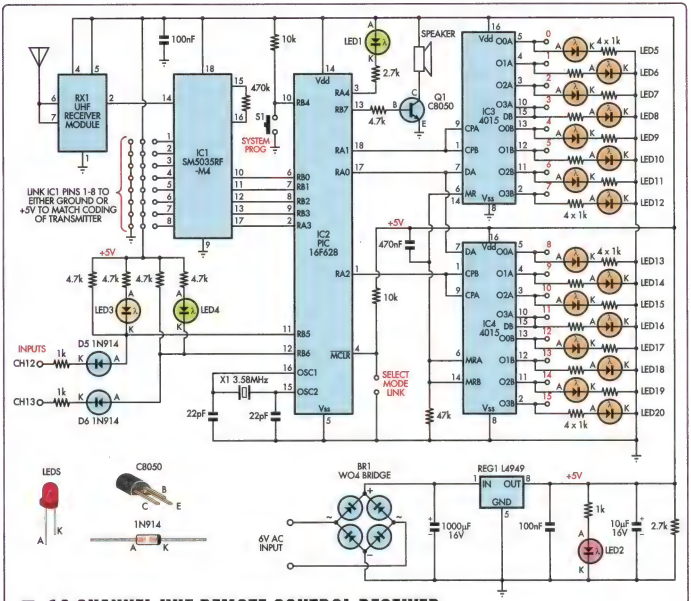
For example, pressing PB3 pulls pins 10 & 11 high via D2 & D1 respec-

Where To Buy Parts

A complete kit of parts for this project (Cat. K192) is available from Oatley Electronics, PO Box 89, Oatley, NSW 2223. Phone (02) 9584 3563. Prices are as follows:

Transmitter (K192A): includes PC board, parts, case & keypad label .. $39
Receiver (K192B): includes PC board plus all parts (no case) $69

Postage and packing is $6 and all prices include GST. Note: the PC board copyrights for this design are retained by Oatley Electronics.



SC 16-CHANNEL UHF REMOTE CONTROL RECEIVER

Fig.2: the coded transmitter signal is picked up by UHF receiver module RX1 and fed to trinary decoder IC1. This decodes the data into 4-bit BCD and drives PIC microcontroller IC2. IC2 processes this BCD data and drives two shift registers (IC3 & IC4).

tively. Similarly, pressing PB11 pulls pin 10 high via D14, pin 11 high via D13 & D11 and pin 13 high via D13 & D12.

As a result, IC1 transmits one of 16 coding sequences, depending on which button is pressed – thus allowing us to distinguish between the channels. At the same time, pressing any of the switches also turns on NPN transistor Q1 via a 10kΩ base resistor. This in turn pulls the Transmit Enable pin (pin 14) of IC1 low and so the coded data stream appears at pin 17 of IC1 and gates the UHF transmitter module.

And that's all there is to the transmitter, apart from a 2.2MΩ timing resistor between pins 15 & 16 of IC1 and a 22nF decoupling capacitor on the supply line. The unit can be run from any suitable 3-9V DC supply (eg, a 9V battery).

Receiver circuit

At the receiver end, the coded transmission is picked up by the UHF receiver module. This signal is then demodulated and the resulting data stream fed out via pin 2 to pin 14 of IC1, an SM5035RF-M4 trinary decoder.

IC1 decodes this data stream into 4-bit BCD. When a valid transmission is received, the decoder places the data on its output pins (pins 10-13), then switches its valid data line, pin 17, high. IC2 detects this valid data signal (at pin 2) and then goes to work processing the BCD data (on pins 6-9) according to its internal software program.

Depending on the mode that the microcontroller is currently operating in and the data it receives, this gives the channel functions described above.

The 470kΩ resistor between pins

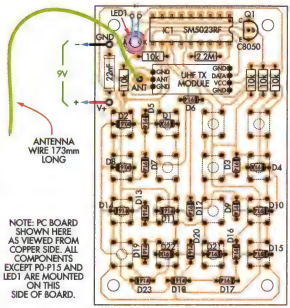


Fig.3: follow this parts layout diagram to assemble the transmitter PC board. Note that all the parts, except for the pushbutton switches, are installed on the copper side of the PC board – see photo.

15 & 16 sets IC1's internal oscillator (so that it matches the oscillator in the encoder), while the associated 100nF capacitor provides supply line decoupling.

Shift registers

Because microcontroller IC2 does not have 16 output pins that we can use, the channel data is sent out in serial form to shift registers IC3 & IC4. Basically, IC3 & IC4 function as "port expanders", since we don't have enough output ports on the microcontroller. They decode the incoming data stream applied to their pin 7 inputs and switch their outputs high or low in response this data.

Channels 0-7 are collectively termed "Bank A", while channels 8-15 make up "Bank B". The data for all channels is sent to both shift registers at the same time but only pin 18 of the microcontroller is clocked (to clock IC3) when Bank A data is being shifted.

Similarly, the microcontroller only provides clock signals from pin 1 when Bank B data is being shifted.

As stated above, channels 12 and 13 require negative going inputs (ie, from some external source) to turn them off once they have been activated. This is done by pulling pins 11 & 12 of IC2 low via diodes D5 & D6 and their series 1kΩ resistors.

LEDs 3 & 4 are used as status indicators while changing security codes. During normal operation, pins 11 & 12 of IC2 function as inputs and the LEDs turn on to indicate incoming low inputs. Conversely, during programming, pins 11 & 12 function as outputs which turn on the status LEDs.

LED1 is the "locked" status indicator LED and is driven by pin 3 of IC2 via a 2.7kΩ resistor. This LED lights when power is first applied (pin 3 low), indicating that the receiver must first be unlocked before it can be used.

Installing the optional Mode Select link pulls pin 4 of IC2 low and switches the operation to Mode 2. Normally (ie, for Mode 1 operation), this pin is held high via a 10kΩ pullup resistor. The 47kΩ resistor and its associated 470nF capacitors reset the two shift registers (IC3 & IC4) when power is applied.

Clock signals for IC2 are provided by a 3.58MHz crystal oscillator based on X1. The two associated 22pF capacitors provide the correct loading for the crystal, to ensure that the oscillator starts reliably.

Pushbutton switch S1 is used for system programming. It pulls pin 10 of the microcontroller low so that new programming values can be entered and stored in the PIC's EEPROM.

Finally, pin 13 of IC2 drives the base of transistor Q1 via a 4.7kΩ resistor. This transistor in turn drives a small loudspeaker which is used as a "beeper" (mainly during programming).

Power supply

The receiver circuit is powered from a 6V AC plugpack supply. Its output is rectified using bridge rectifier BR1 and filtered by a 1000μF capacitor before being fed to regulator REG1.

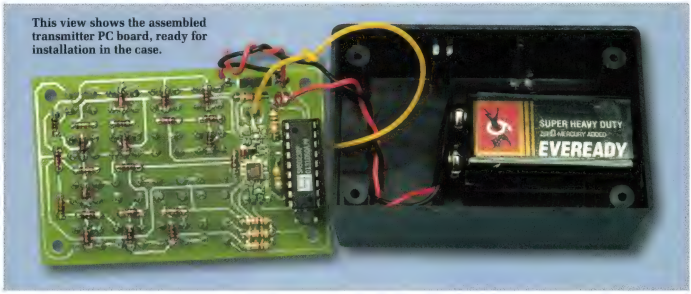
The +5V output from REG1 is filtered using 100nF and 10μF capacitors and powers all the circuitry. It also lights power indicator LED2 via a 1kΩ resistor. The 2.7kΩ resistor across the supply ensures that the filter capacitors quickly discharge when the power is switched off.

Table 2: Capacitor Codes

Value	μF Code	EIA Code	IEC Code
470nF	0.47μF	474	470n
100nF	0.1μF	104	100n
22nF	0.022μF	223	22n
22pF	-	22	22p

Table 1: Resistor Colour Codes

❑	No.	Value	4-Band Code (1%)	5-Band Code (1%)
❑	1	2.2MΩ	red red green brown	red red black yellow brown
❑	1	270kΩ	red violet yellow brown	red violet black orange brown
❑	1	47kΩ	yellow violet orange brown	yellow violet black red brown
❑	7	10kΩ	brown black orange brown	brown black black red brown
❑	3	4.7kΩ	yellow violet red brown	yellow violet black brown brown
❑	1	2.7kΩ	red violet red brown	red violet black brown brown
❑	21	1kΩ	brown black red brown	brown black black brown brown



This view shows the assembled transmitter PC board, ready for installation in the case.

This is necessary to ensure that the microcontroller resets correctly when the power is switched off and then on again within a relatively short period.

Construction

Construction can start with the transmitter assembly – see Fig.3. Note that all components except for the switches are mounted on the copper side of the PC board.

The first step is to install the socket for IC1. This job is straightforward but make sure that you don't inadvertently create any solder bridges between the IC pads and the adjacent parallel copper tracks.

That done, you can install the UHF transmitter module. It's just a matter of orienting the module so that its solder pads at either end line up with those on the PC board. Once you have the module correctly aligned, it can be held in position with a clothes peg (be careful not to damage the coil) while you solder the connections.

You will need good eyesight, a good light and a fine-tipped soldering iron for this job. If you have a magnifying glass or a Mag-Lite, then so much the better. It's also best to lightly tack-solder a single connection at either end first, then check the module's alignment before soldering the remaining connections.

Transistor Q1, the diodes, the resistors and the 22nF capacitor can now all be installed on the copper side of the PC board. That done, the 16 push-

The 16 pushbutton switches (PB0-PB15) are installed on the transmitter PC board in the conventional manner.

This view shows the back of the case lid, after the switch membrane has been attached – see text.

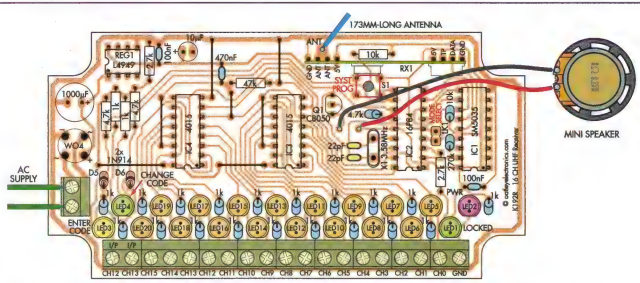


Fig.4: install the parts on the receiver PC board as shown here but don't plug the ICs into their sockets until after the initial test procedure has been completed (see text).

Parts List

Transmitter

1 transmitter PC board, 78 x 50mm
1 TX434 433.92MHz UHF transmitter module
1 18-pin DIL IC socket
16 miniature pushbutton switches (PB0-PB15)
1 22nF MKT capacitor

Semiconductors

1 SM5023RF trinary encoder (IC1)
1 C8050 NPN transistor (Q1)
23 1N914 diodes (D1-D23)
1 miniature red LED (LED1)

Resistors (0.25W, 5%)

1 2.2MΩ
5 10kΩ

Receiver

1 mini-speaker
1 receiver PC board, 126 x 64mm
1 miniature PC-mount pushbutton switch (S1)
1 RX434 433.92MHz UHF receiver module
1 2-way pin header
2 18-pin DIL IC sockets
2 16-pin DIL IC sockets
1 8-pin DIL IC socket
9 2-way PC-mount screw terminal blocks
1 3-way PC-mount screw terminal block

Semiconductors

1 SM5035RF-M4 4-bit decoder (IC1)
1 PIC16F628-04 programmed microcontroller (IC2)
2 4015 dual 4-bit shift registers (IC3,IC4)
2 1N4148 signal diodes (D1,D2)
1 W04 bridge rectifier (BR1)
1 L4949 5V regulator (REG1)
1 C8050 NPN transistor (Q1)
2 5mm green LEDs (LED1, LED4)
1 5mm red LED (LED2)
1 5mm yellow LED (LED3)
16 5mm orange LEDs (LED5-LED20)
1 3.579MHz crystal (X1)

Capacitors

1 1000µF 16V electrolytic
1 10µF 16V electrolytic
1 470nF monolithic
2 100nF monolithic
2 22pF ceramic

Resistors (0.25W, 5%)

1 270kΩ
3 4.7kΩ
1 47kΩ
1 2.7kΩ
2 10kΩ
21 1kΩ

Footnote: a complete kit of parts for this design is available from Oatley Electronics – see panel for details.

button switches can be installed from the other side of the board. They must all be oriented correctly but they only fit one way, so you can't get them wrong.

LED1 is installed by pushing it into a 3mm hole from the copper side of the PC board. It's leads are then bent over and soldered to two pads on the PC board but make sure you get these the right way around – the anode (A) lead goes to the V+ input on the PC board.

The LED can be secured in position using a small dab of epoxy adhesive.

The transmitter board can bow be completed by fitting a 170mm-long insulated wire antenna at the "ANT" position.

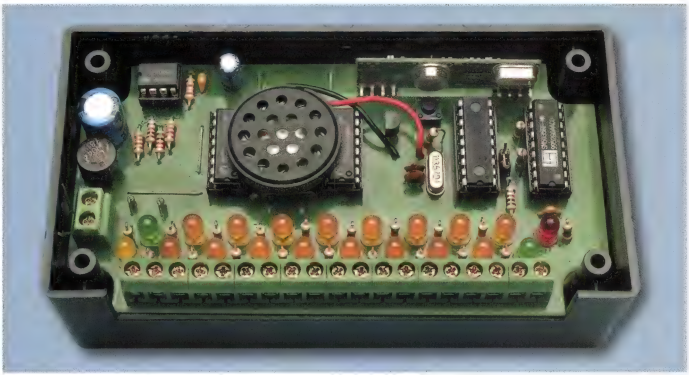
The two parallel tracks adjacent to pins 1-8 of IC1 let you set the transmission code – the inside track is at 0V, while the outside track is at +9V (note: it's the opposite way around on the receiver). This makes it easy to tie the coding pins either high or low by creating solder bridges between the pads and the tracks.

Alternatively, you can also leave some of the pins open circuit (O/C).

For the time being, it's best to leave pins 1-8 all O/C, so that there's no confusion when it comes to testing.

Transmitter housing

The completed transmitter board is housed in a small plastic utility case and the pushbutton switches are activated by pressing a keypad membrane



The assembled receiver PC board is housed inside a cut-down plastic utility case as shown here. Note the mounting method for the mini-speaker – it's secured to the tops of IC3 & IC4 using a few "blobs" of silicone sealant.

that's affixed to the top of the lid.

The first job is to use the supplied template to mark out the 16 key positions on the lid. The keypad cutouts can then be made in the lid by drilling a series of small holes around the inside perimeter of each marked square, knocking out the centre pieces and filing for a smooth finish – see photo.

That done, the keypad membrane can be trimmed to size and carefully affixed to the lid. It's self-adhesive, so it's just a matter of removing the backing paper before placing it in position. You then have to cut sixteen 6 x 7mm squares from the scrap piece of membrane material and stick them to the back of the membrane through each keypad hole.

This is necessary to prevent the membrane from sticking to the buttons when the keys are pressed.

The PC board sits on top of the corner pillars in the base of the case and is held in position when the lid is screwed down. Note that it will be necessary to remove about 3mm from the top of each pillar, so that they sit 4mm below the top edge of the box. In addition, the matching posts at the corners of the lid have to be filed down by about 1mm.

The job is a bit fiddly and has to be done carefully so that the keypad membrane just touches the tops of the switches when the lid is screwed down.

Receiver assembly

Now for the receiver assembly. Once again, this is straightforward and its just a matter of installing the parts on the board as shown in Fig.4

Begin by installing the wire links and resistors, then install, crystal X1, the capacitors, switch S1, the 2-pin header for LK1, the bridge rectifier (BR1) and the IC sockets. Take care to ensure that the transistor and bridge rectifier are correctly oriented. The same goes for the electrolytic capacitors but the crystal can go in either way.

Next, you can install the 5mm LEDs, taking care to ensure they are all correctly oriented. They can be followed by the PC-mount screw terminal blocks.

Leave all the ICs and the UHF receiver off the board for the time being. They are installed later, after you've performed a few basic tests. Regulator REG1 should be installed, however.

Now for the smoke test – apply power and check that LED 2 lights. If it does, use your multimeter to measure the voltage at the output of REG1 – it should be 5V. This voltage should also be present on pin 14 of IC2's socket.

If all is correct, switch off and plug the ICs into their sockets taking care to ensure that each is correctly oriented and that the correct IC goes in each socket. That done, you can install the UHF receiver module (the round metal can for the SAW filter goes towards switch S1).

Finally, complete the board assembly by installing a 173mm-long antenna lead and wiring up the mini speaker. The latter can be secured by using some silicone sealant to attach it to the tops of IC3 & IC4 – see photo.

OK, now for a second smoke test. Make sure that the "Mode Select" link is removed, then apply power to the

Table 3: Default Values

- Channels 0-5 set for toggle outputs.
- Channel 8 time set at 10s; channel 9 set at 60s.
- Channel 11 time set at 10 minutes; channel 11 set at 60 minutes.
- Channels 14 & 15 set at 60 minutes each.
- The user code is set to 10-10-10-10.
- In Mode 2, all channels are set for toggling outputs.

System Programming: Step-By-Step

Programming the unit is quite straightforward using the following step-by-step guide. Note that all programming is done with the Mode Select link removed – ie, programming is done with the receiver operating in mode 1.

Changing the user code

The user code is changed as follows:

(1). Press and hold down the pushbutton switch S1 in the receiver. The "happy" sound will be heard.

(2). Press button 1, 2 or 3 on the transmitter (any of these buttons will select the "code program mode"). A single tone is heard and the "change code" LED will come on.

(3). Enter the old user code. If this is the first time that the code is being changed after building the unit, then the "old user code" is the default of 10-10-10-10.

(4). Press the 12 key. If the user has entered the correct "old code", the "happy" sound will be heard, the "change code" LED will go out and the "enter new code" LED will come on. Conversely, if an incorrect code was entered, the "sad" sound will be heard and all programming will be cancelled. The procedure must then be restarted after first releasing pushbutton switch S1.

(5). Enter a new 4-digit code, then press key 12 to write the new code into the PIC's EEPROM. The "happy" sound will be heard and the "enter new code" LED will go out.

(6). Release pushbutton switch S1 to resume normal operation.

Programming the channel times

Channels 8-11 can be programmed with delay times as follows:

(1). Press and hold down pushbutton switch S1.

(2). Select the channel to be programmed by pressing its key on the transmitter. The speaker will give a series of beeps equal to the channel number.

(3). Enter the required time in seconds for channels 8 & 9 and in minutes for channels 10 & 11. The maximum number that can be entered is 255 and a beep will accompany each key press.

(4). Release pushbutton switch S1 – the "happy" sound will be heard.

As an example of setting channel 11 to 105 minutes, do this:

(1). Press and hold pushbutton switch S1.

(2). Press key 11 on the transmitter – 11 beeps will be heard.

(3). Press key 1, 0 & 5 on the transmitter. A beep will follow each key press.

(4). Release switch S1. The "happy" sound will be heard.

That's it – channel 11 is now set for 105 minutes. This time is also stored in the PIC's EEPROM each time the unit is powered on.

User code fail-safe

The PIC program includes a facility to reload the default user code, in case the programmed user code is forgotten.

The procedure is as follows:

(1). Install the Mode Select link so that the receiver is now operating in Mode 2.

(2). Press and hold down pushbutton switch S1, then turn the power on. The "happy" sound will be heard followed by the "sad" sound. The change code LED and the new code LED will both come on (LEDs 3 & 4).

(3). Enter the supplied fail-safe code, then press the Enter key (key 11). Provided the correct code has been entered, the system will now be reprogrammed with the default user code of 10-10-10-10. Conversely, if the entered fail-safe code is incorrect, the sad sound will be heard and you must re-enter the fail-safe code.

Once the default code has been reprogrammed, the system operation will return to normal and you can then reprogram a new user code.

Do not loose the fail-safe code that's supplied when you purchase your kit. If you do, the unit will be rendered useless if you forget your user code.

unit – you should immediately hear a 3-note sound. This is the "happy" sound and you will hear it a lot during the operation of this project.

LED1 (the "locked" indicator) should come on as well. If it does, then the receiver is probably working correctly. If not, then you have a fault somewhere and you will need to go back over your work.

The receiver board is housed in a plastic utility case, as shown in the photos. This involves cutting away a 103 x 24mm section from one side of the lid, to provide access to the indicator LEDs. In addition, a matching 103 x 17mm section is cut away from one side of the base, to provide access to the screw terminal blocks.

The front of PC board rests on the lip of the cutout, while the back rests on top of the integral slots at the back of the case. These slots have to be trimmed, so that their tops sit 17mm below top of the base (ie, so that they line up with the lip of the cutout).

Final testing

At this stage you have connected power and the microcontroller is waiting for the program to be unlocked. To do this, enter the default user code of 10-10-10-10 followed by the enter (11) key. You should be rewarded with the "happy" sound.

The system is now ready for use with all programmable functions set to the defaults – see Table 3.

Once the system has been unlocked, it can be easily locked again by pressing and holding either the 8, 9, 10 or 11 key for more than 3s. At the end of 3s, the Locked LED will come on and the "happy" sound will be heard.

Note that because nothing happens when a key is first pressed (only when it is released), none of these channels will be affected provided the button is held down for more than 3s.

Finally, once the unit is working correctly, you can code the pin 1-8 address lines. As indicated previously, you code each address pin by either leaving it O\C or by bridging it to the supply rail or to 0V. Just make sure that the transmitter and receiver codes match.

Footnote: technical queries on this design can be directed to the author, Jeff Monegal. Jeff can also customise the PIC software if you wish to change the channel functions. His email address is: **jmonegal@ozemail.com.au**

VINTAGE RADIO

By RODNEY CHAMPNESS, VK3UG

Vibrators: the death knell of heavy, expensive dry batteries; Pt.2

Last month, we looked at the basics of vibrator power supplies as used in many vintage radio receivers. This month, we take a look at interference suppression in vibrator supplies and describe how to service them.

Fig.1 shows the circuit details for a typical vibrator power supply, in this case from a HMV 268/328 vibrator receiver. In operation, the vibrator (VIB) alternately "earths" the ends of the primary winding of T2, thereby causing pulses of current to flow through each half-winding to earth via vibrator contacts 1, 5 & 6.

The transformer (T2) steps up the primary voltage and the resulting secondary voltage is then rectified by contacts 2, 4 & 6 in the vibrator. The output, at the centre-tap of the secondary, is DC with ripple on it - much like the hum voltages in an AC supply. Note that the vibrator transformer has a "buffer" capacitor (C37) across it and this has voltage rating of 2000V.

A basic vibrator power supply generates considerable electrical interference (vibrator "hash") which left unsuppressed, will completely drown out all but the strongest radio stations. However, vibrator radios were mostly used in rural areas where radio signals were relatively weak.

To overcome the interference, radio frequency chokes (RFCs) were fitted in series with both the low tension (LT) rail and high tension (HT) lead. In Fig.1, these RFCs include CK1 & CK3 in the LT rail and CK2 in the HT rail. In addition, radio frequency (RF) bypass capacitors were connected between LT & HT rails and earth - ie, C40, C41 & C42. In practice, these bypasses were fitted near the RF chokes and as a result, interference on these lines was virtually eliminated.

However, a vibrator supply will also radiate interference directly from the supply leads and from other components prior to the filters. To overcome this, the supply is shielded within a metal box - sometimes double-shielded, as can be seen by the dotted line enclosures around the vibrator supply in Fig.1. The earth points in vibrator power supplies also had to be chosen with care and some supplies used "one point" earthing, where all leads that carry interference are earthed at one point only.

Five typical vibrators (from left to right): Van Ruyten 32V 200W dual interrupter vibrator, Oak V6606 6V dual interrupter (with strapped pins) vibrator, Oak V5124 6V synchronous vibrator, Plessey 121HD4 12V non-synchronous vibrator and Ferrocart M437 6V non-synchronous vibrator.

Battery filament lines

The battery filament lines are also filtered to remove any ripple and this is accomplished in Fig.1 by power choke CK5 and electrolytic capacitor C43. However, you may be wondering why the negative power lead and the positive power leads are split into two wires each. This was done so that the ripple along the vibrator positive and negative supply lines was not impressed onto the filament lines.

In practice, the battery filters out most of the ripple as it acts as a very large capacitor. Note that the voltage

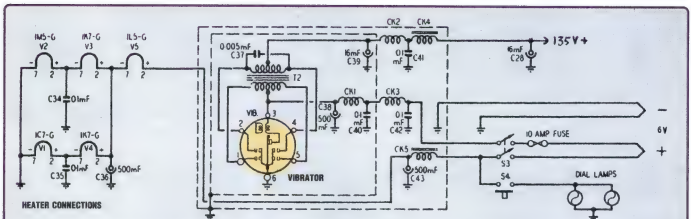


Fig.1: the circuit diagram for the HMV 268/328 filament and vibrator supply. The vibrator is a synchronous type, since it also rectifies the output on the transformer secondary windings.

drop to the vibrator supply must be minuscule for efficient operation, so no iron-cored filter choke is fitted to this line.

Note also that the current drawn by the supply is quite variable and "peaky" over each cycle that the vibrator goes through. As a result, capacitor C38 (500μF) is fitted to smooth the voltage at the supply input so that the voltage does not sag when high current is being drawn.

The filament line requires effective filtering and bypassing for the receiver to work correctly. As already mentioned, CK5 and C43 ensure that almost pure DC is fed to the 1L5G valve. Then, on the negative side of the 1L5G filament, another electrolytic capacitor is wired to earth. This filters out any audio signals (ripple) which may appear on the filament line due to variations in the current drain when the valve is amplifying an audio signal.

If this is not done, an audio signal will be present on the filaments of all the other valves in the receiver and this will cause many strange effects. Capacitors C34 and C35 bypass any RF signals to earth, just as a bypass capacitor fitted to the cathode of an AC valve does.

The HT line also has filtering to remove the vibrator ripple voltage (hum, if you like) from the receiver HT supply. This is achieved using C39, CK4 & C28. This filter network is virtually the same as that used in AC receivers of the same era.

The Oak, Van Ruyten and Ferrocart vibrators, opened up to show their workings. Note the multiple point contacts.

Mechanical noise

Along with the electrical noise, it was also important to remove the mechanical noise of the vibrator itself. As a result, vibrators were manufactured with internal resilient rubber mounts at the upper end of the vibrator case, along with rubber mounts at the base (see photo). The vibrator was then mounted in a 4, 5, 6 or 7-pin valve socket which was usually installed on a resilient mount (eg, the HMV 2V vibrator supply had its vibrator installed on a rubber-mounted socket, while the case was enclosed in a rubber sock).

The supply enclosure was then often mounted on grommets and attached to the chassis with earthing only at one point for interference suppression purposes. The mechanical noise is virtually non-existent when all of this is done. However, not all of these soundproofing measures were used (or were necessary) in all supplies.

How the vibrator works

Let's now take a close look at the circuit of the HMV 268 power supply shown in Fig.1. As shown, the +6V rail from the battery is applied (via CK3 & CK1) to the centre-tap of the primary of the vibrator transformer (T2). It is also applied to pin 3 of the vibrator.

From pin 3, the current flows down through the reed drive coil, through the top set of points and finally through the reed to earth via pin 6. All other sets of points are initially open. The

current through the coil causes it to become an electromagnet which attracts the reed to the left.

As a result, the moving reed makes contact with points 1 and 2 and so these two points are earthed.

At the same time, the reed drive contacts (at the top of the vibrator) separate and the magnetic field collapses. The reed then reverses direction, contacts 1 & 2 now separating from the reed contacts. The reed then continues to the right, making contact again with the reed drive point and also with contacts 4 & 5 which are now earthed via pin 6.

The current through the vibrator coil once again causes the reed to reverse to reverse direction and contacts 4 and 5 separate from the reed points. The reed then continues on to break the coil current and make contact with contacts 1 & 2 again and so this cycle is repeated for as long as voltage is applied to pin 3.

The frequency and amplitude of the springy reed is governed by two factors: (1) its natural frequency of vibration and (2) the setting of an adjustable drive point. This adjustment can be seen on the side of the vibrator frame (V5124). In practice, the frequency of operation of vibrators varies with the make and its intended purpose. Most radio receiver types operate at 100Hz or 150Hz. However, the Van Ruyten vibrator operates at 50Hz, as it is usually used in a 32V DC to 240V 200W AC mains output supply.

Increasing the voltage

OK, let's now take a look at how the low voltage DC is increased to a much higher DC voltage in a vibrator supply.

As discussed above, when the reed moves to the left, contact 1 is connected to earth and this in turn earths one side of transformer T2's primary winding. As a result, current flows via the centre tap of the transformer and through the winding to earth via pins 1 & 6 of the vibrator. The current builds up for a short time and then the vibrator points open again and the current ceases.

When the reed contacts reach the opposite (righthand) side, the righthand end of the transformer's primary winding is earthed via pins 5 & 6. As a result, current now flows is this half of the transformer primary to earth (ie, in the opposite direction). This cycle is then repeated, so that the 6V supply is alternately "switched" across each half of the transformer primary.

The transformer has a step-up ratio of around 1:25 and so the secondary voltage will be around 150V across each half of the secondary winding. This alternating voltage is now recti-

Photo Gallery: Philips Model 2510 Consolette (circa 1929)

Liveried in mottled red and black, the Philips Model 2510 consolette comes complete with a speaker cabinet that, with its imitation drawers, is reminiscent of an Art-Deco writing bureau. The "trunk" on top is steel-framed with timber inset panels and houses a 5-valve TRF receiver. This has a hinged lid and the escutcheon features a celluloid viewer through which the drum dial is read. The tuning and volume controls were situated at either end of the set.

(Restored by Maxwell L. Johnson, Tasmania; photo by Ross Johnson).

Van Ruyten vibrator showing the adjustments for setting the correct points gaps and the reed drive.

fied and this is done using two extra pairs of contacts in the vibrator.

As shown in Fig.1, the vibrator earths the lefthand end of the transformer secondary in synchronism with the lefthand end of the primary - ie, via contacts 2 & 6. Similarly, it earths the righthand end of the secondary in synchronism with the righthand end of the primary, this time via contacts 4 & 6. As a result, the output from the transformer (taken at the centre tap) is rectified and this rectified DC voltage is then fed to the LC filter network (C39, CK2, C41, CK4 & C28) to derive a nominal 135V rail.

In practice, however, the secondary contacts are slightly staggered, so that they close and open a short time after the primary contacts. So why was this done?

The answer is that when contact 1 makes contact with the reed, T2's primary winding starts to draw current. At the same time, the secondary will have little or no voltage across it. This means that if contact 2 made contact with the reed at exactly the same time as pin 1, there would be no induced voltage across the secondary. Furthermore, if C39 were charged, it would discharge back through T2's secondary and pin 2 of the vibrator to earth.

The same situation applies if contact 4 were to make contact with the reed at the same time as contact 5. This is clearly not what we want and the result would be a lot of sparking at the secondary contacts.

To eliminate this problem, the secondary contacts are adjusted so that they do not close until the voltage developed across each half secondary winding has risen to near its peak. This will be slightly greater than the voltage across C39. As a result, when the secondary contacts switch, very little current flows through them and this eliminates the sparking.

In practice, the timing is controlled by the difference in the gap between the primary and secondary points. In a typical Oak synchronous vibrator (V5124), the primary points gap is 0.003 inches, while the secondary points gap is 0.005 inches.

Buffer capacitor

Now we come to the buffer capacitor. In the HMV 268 circuit, it is wired across the entire secondary winding and is a 5nF (.005μF) capacitor rated at 2000V (C37). Note that the voltage rating is important, as transient voltages much higher than the nominal output voltage of the supply are developed when the primary vibrator points open.

In other circuits, the buffer capacitor may be wired across the primary, or across both the primary and the secondary in some instances. Another variation is to use two capacitors, one across each half of the primary or secondary winding. In some cases, a low-value resistor is wired in series with the buffer capacitor.

The value of the capacitor depends on just where it is wired into the circuit and the inductance of the primary or secondary winding. In operation, the buffer resonates the transformer at approximately the frequency of the vibrator operation. As a result, the vibrator will have minimal sparking at the contacts and the current drain without a load will be greatly reduced.

Servicing vibrator supplies

Servicing vibrator power supplies can be divided into two parts: (1) overhauling the mechanics of the vibrator itself and (2) overhauling the associated electronic circuitry.

The first job is to service the vibrator points and that involves disassembling the vibrator. Unsealed types can easily be dismantled. In the case of the Oak vibrators, it is necessary to first desolder the lug at the side of the base and then lever out the circlip. It's then just a matter of wriggling the base so that the internal assembly can be withdrawn from the case.

A somewhat more brutal method needs to be used with Ferrocart vibrators. In one of the photographs, a pair of side-cutters can be seen near the base of the vibrator. The side-cutters are used to peel the rolled in edge of the metal can away from the base. Once this is done, the vibrator can be slid out of its case.

Of course, this mucks up the nice tidy fold so that it looks slightly mutilated when the vibrator is later reassembled. However, there's not much choice if you want to restore this type of vibrator. It obviously wasn't designed to be serviced but replacements are not easy to obtain.

Once the vibrator has been dismantled, the first job is to check that the reed coil has continuity. Obviously, there's no point in going further if this is open circuit. If the points are not too badly pitted, they can be cleaned using some very fine wet and dry paper or by using a contact cleaner. Push them lightly together while running the paper between them, until the faces are smooth and shiny. Wash out any muck with methylated spirits and check that there is no corrosion on the points, as this can stop them from making good electrical contact.

If the points are in poor condition, an automotive points file is worth a try. Make sure that you keep the file parallel to the faces of the points and be careful not to bend the points further apart during this process.

A vibrator in good condition will start and run on a voltage that's about 2/3rds of its normal running voltage. In addition, a 6V vibrator that has an independent reed drive system (eg, the Oak synchronous types) can be

A pair of side cutters can be used to peel back the crimped edge of the Ferrocart M437 6V non-synchronous vibrator so that it can be removed from its case. By contrast, the Oak vibrator at right is opened by removing a circlip and desoldering a solder lug.

used in a 12V or 32V system if a suitable dropping resistor is placed in series with the reed coil. A 12V type could also be used on 32V using the same technique, while some 32V Operatic receivers used a 24V vibrator.

Next, it would be a good idea to check the resilient mounts inside the vibrator. The rubber socket at the end of the case is usually OK but the rubber around the base may have deteriorated. If so, it's a good idea to disconnect the leads to the plug and slip some flexible insulated sleeving over them before resoldering them. Make sure that the solder doesn't get down into the flexible braided lead during this procedure.

Once this has been done, pack up the space alongside these braided leads with foam plastic to retain the resilient mount effectiveness.

It isn't a bad idea to run the vibrator pack with the set disconnected and the cover removed so that you can check for sparking and correct general operation. This should be done particularly if the output voltage is low on load. However, don't do this until the buffer capacitor has been checked and if necessary, replaced.

In some cases, it may be necessary to bend the fixed points closer or further away from the vibrating points to improve operation. This can be done using long-nosed pliers (without power applied, of course). Be sure to adjust the points so that they remain parallel with each other.

The reed drive adjustment (if fitted) may also need to be altered. An oscilloscope is desirable so that you can check the check the various waveforms around the transformer after making adjustment but is by no means essential.

Note that the gaps between the points for the Oak synchronous vibrator are 0.003 inches for the primary points and 0.005 inches for the secondary points. By contrast, the Ferrocart non- synchronous vibrator has a spacing of 0.008-inch, while the Van Ruyten is spaced at 0.012 inches. A set of automotive feeler gauges similar to those shown in one of the photographs is necessary to accurately set the gaps.

Even without feeler gauges, it's possible to adjust the points so that the vibrator operates satisfactorily. However, always make sure that the secondary contacts are spaced wider than the primary ones on a synchronous vibrator.

With the Oak and the Van Ruyten units, the reed drive can be adjusted by shifting the position of the fixed point for the reed coil. Experiment as necessary to see what effect this has on the "vigour" of the vibration (the more the better). Don't adjust the other points until the reed is vibrating correctly.

Checking the electronics

Checking out the electronic circuitry is straightforward since there are only a few parts involved. The first step is to check all the wound components (inductors and RFCs), although they are usually OK. That done, you should check all the paper and electrolytic capacitors, replacing any that appear to be defective.

One of the most critical components is the buffer capacitor. It should be checked with a high voltage tester for leakage and should also be checked for capacitance. If you don't have the necessary equipment to check this capacitor, just replace it if the supply draws a high current when there is no load.

A typical 6V battery set vibrator supply should draw about 0.8A when connected to a set using 2V valves. By the way, high-voltage capacitors suitable for buffer use are often available from TV parts suppliers (eg, WES Components, Ashfield, NSW).

Summary

Many vintage radio restorers don't feel confident about dealing with vibrators and vibrator power supplies but most can be serviced relatively easily. Vibrator radios are well worthwhile collecting – they are not all that common and are another important part of our radio heritage. **SC**

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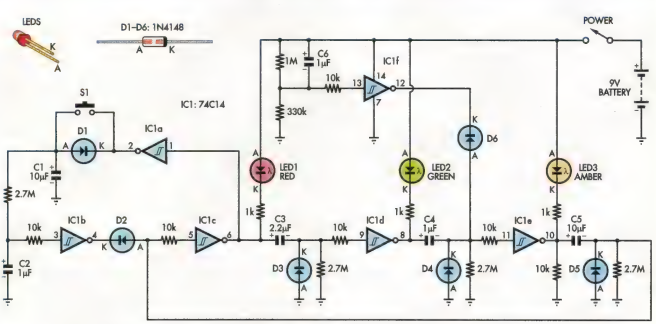
Interesting circuit ideas which we have checked but not built and tested. Contributions from readers are welcome and will be paid for at standard rates.



Interactive toy traffic lights

This toy traffic signal uses a single low-cost hex Schmitt-trigger inverter IC (IC1a-IC1f) to directly drive three coloured LEDs (red, green and amber).

At switch-on, the circuit lights the red signal for 30s, then shows green for 6s, then amber for 3s. It then repeats the sequence. Interaction is provided by pushbutton S1 which abbreviates the red period to a further 3s only, if it is pressed while the red signal is showing.

Sequencing of the three LEDs is controlled by inverters IC1c, IC1d & IC1e, while the electrolytic capacitors at the inverter outputs and their associated 2.7MΩ resistors determine how long each LED stays on. Diodes D3, D4 & D5 discharge the timing capacitors for the next two LEDs in the sequence while the current LED is on.

Note also the 10kΩ resistor at the input of each inverter. These protect the inverter inputs from being damaged by the negative voltage produced when the previous output goes low while its timing capacitor is fully charged.

The circuit is forced into the red state at switch-on by IC1f and its associated circuitry. What happens is that IC1f briefly pulls the negative end of the amber timing capacitor (C4) low via D6 at switch-on. As a result, IC1e's output goes high and turns the amber LED (LED3) off.

The red timing capacitor (C5) is in a discharged state at power-up because D5 and the 10kΩ resistor at the output of IC1e discharge it when the power is off. As a result, when IC1e's output goes high, IC1c's output goes low and turns LED1 (red) on.

This also pulls the input of IC1d low, so IC1d's output goes high, turning the green LED off.

The amber timing capacitor (C4) at the output of IC1d charges rapidly when it receives the negative pulse from IC1f. That's because its positive end is high when the green LED is off and the pulse takes its negative end low.

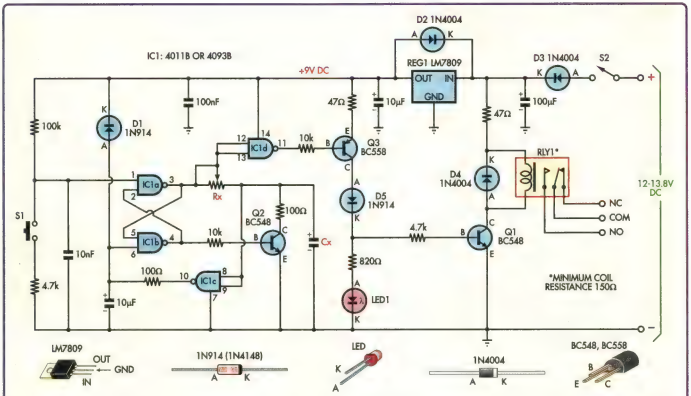
When pin 12 of IC1f subsequently goes high at the end of the switch-on pulse, this remains charged and holds the input of IC1e low, so the amber LED (LED3) remains off.

Pushbutton operation is controlled by IC1a and IC1b, which rapidly charge the red timing capacitor (C5) 3s after switch S1 is pressed. This works as follows: pin 2 of IC1a is high when the red LED is on, so pressing S1 during the red period rapidly charges C1. C2 then charges slowly from C1 via a 2.7MΩ resistor.

After about 3s, C2 reaches IC1b's trigger threshold and so pin 4 of IC1b switches low. Because the red LED is on, the amber LED is off. This means that pin 10 of IC1e is high and so the positive end of C5 is also high. When IC1b's output goes low, it pulls the negative end of C5 low via D2, thereby rapidly charging this timing capacitor.

This ends the red period and so the red LED (LED1) turns off. As a result, IC1a's output goes low and C1 and C2 discharge via D1, ready for the next time switch S1 is pressed.

Andrew Partridge,
Kuranda, Qld. ($45)



Multipurpose flipflop timer

This particular timing circuit can be used to time one-shot events from a few seconds to a few hours. And in standby mode (ie, with RLY1 and LED1 off), its power consumption is very low.

The heart of this circuit is a low-cost CMOS 4011 quad NAND gate, with IC1a & IC1b configured as a standard Set/Reset flipflop. Briefly pressing switch S1 to start the timing sequence pulls pin 1 of IC1a low and, as a result, pin 3 switches high.

Two things happen while pin 3 is high: capacitor Cx begins charging via potentiometer Rx; and (2) pin 11 of IC1d will be low, which means that transistors Q3 and Q1 are both on. As a result, both LED 1 and relay RLY1 are also on.

RLY1 and LED 1 remain on until Cx has been charged up to about 70% of Vcc (ie, the supply rail). At this point, pins 8 & 9 of IC1c are pulled high and so its pin 10 output goes low and resets the flipflop by applying a low to pin 6 of IC1b. This causes pin 3 of IC1a to go low and so LED1 and RLY1 switch off and the timing period ends.

At the same time, pin 4 of the flipflop goes high and this turns on transistor Q2 while ever the flipflop is held reset. This ensures that Cx is discharged, so that the circuit is ready the next time S1 is pressed.

Diode D1 and its associated 10µF capacitor reset the flipflop when power is first applied, so that LED1 and RLY1 remain off until S1 is pressed. D4 is included to protect Q1 against the back-EMF that's generated when the relay switches off.

Choosing appropriate values for Cx & Rx for a given time delay is straightforward. The formula is T = 1.24 x Rx x Cx, where T is the delay time in seconds.

As an example, let's assume that we require a time delay of 10s using a value of 100µF for Cx. Now we just need to calculate the value of Rx as follows:

Rx = 10s/(1.24 x Cx) = 80,645Ω

In this case, an 82kΩ resistor would be the closest value.

You can use either a fixed resistor for Rx or you can use a potentiometer (or trimpot) which can be adjusted to give the required time delay. Note that the value of Rx should not be any more than a few megohms.

Power for the circuit can be derived from any 12V DC source. This is then fed to 3-terminal regulator REG1 to derive a 9V rail to power the circuitry. The exception here is the relay circuit, which is powered from the 12V rail. Diode D3 protects the circuit against incorrect supply polarity.

Trent Jackson,
Dural, NSW. ($40)

Automatic white-LED garden light

This white-LED driver circuit is ideal for use in a garden light. It automatically turns the LED on at night and runs from a single 1.2V nicad cell which is recharged by a solar cell during the day.

The prototype used the existing casing and solar cell from an old garden light but you could also use a solar cell from a solar education kit.

Diode D1 allows the solar cell to charge the battery during the day and prevents it from discharging back into the solar cell at night. Transistor Q1 controls the LED driver circuit. This transistor is normally on during the day (ie, when there is output from the

continued next page

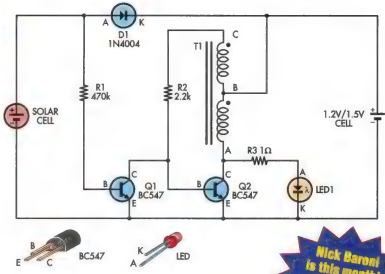
solar cell) and so Q2 and the LED are off.

At night time, Q1 is off and this allows a simple blocking oscillator circuit based on T1, R2 and Q2 to operate. This circuit in turn drives LED1 via a 1Ω resistor which limits the peak current into the LED.

T1 is wound bifilar, with the two windings configured to produce a centre-tapped winding. Winding AB is the main primary winding and winding BC is the feedback winding. The number of turns and the core used are not critical. The prototype worked with a toroid scrounged from an old computer power supply, as well as with a small ferrite suppression bead and an Altronics L5110 core.

The toroids were wound using 10 turns of 0.25mm wire, while the ferrite bead worked with just five turns of 0.25 mm wire through the hole (that's all that would fit).

The oscillator works like this: when Q1 turns off, current flows through R2 and turns Q2 on. This causes current to flow through winding AB and the core produces a magnetic flux. And that in turn causes end C on the transformer to rise above the battery voltage and turn Q2 on hard.



When the core saturates, the voltage at C drops back to the battery voltage, thus reducing the current in winding AB. As this happens, the flux in the core starts to fall and this causes the voltage at C to drop below 0.6V. As a result, Q2 turns off and because there is now no current in AB, the flux in the core starts to collapse.

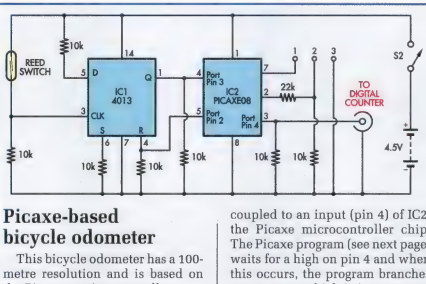
What happens now is that the voltage on end A of the windings rises above the battery voltage. When it gets to 3.2-3.6V with respect to ground, LED1 "fires" and current flows from the battery via BA, through the LED and back to the battery.

When the flux is spent, LED1 turns off and end C returns to the battery voltage. Current now flows through R2 and into the base of Q2 and the whole cycle starts over again.

Finally, when the Sun rises the following morning, Q1 turns on, robs Q2 of its base drive, the oscillation stops and LED1 goes out.

Nick Baroni,
Willetton WA.

Nick Baroni is this month's winner of the Peak Atlas LCR Meter



Picaxe-based bicycle odometer

This bicycle odometer has a 100-metre resolution and is based on the Picaxe08 microcontroller.

A magnetic reed switch fixed to the bicycle frame is used to detect the wheel rotations. This reed switch is activated by a magnet fixed to the wheel spokes and triggers an RS flipflop based on IC1.

The "Q" output of the flipflop is coupled to an input (pin 4) of IC2, the Picaxe microcontroller chip. The Picaxe program (see next page) waits for a high on pin 4 and when this occurs, the program branches to a counter which is incremented with each wheel revolution.

Subsequently, the program sets a high on pin 5 which resets the flipflop to a low state. This prevents retriggering on a single pass of the magnet past the reed switch. It also prevents retriggering in the event that the bicycle is stationary but the magnet is adjacent to the reed switch.

My bicycle has a wheel diameter of 700mm, corresponding to a circumference of 2.2m. This corresponds to 45.5 revolutions over a distance of 100 metres. As a result, the program alternately counts 45 revolutions and 46 revolutions to give the necessary 45.5 revolutions/100 metres.

Each time a count of 45 or 46 is reached, the program sends a 1ms pulse to pin 3 using the 'Puls' subroutine. This increments the digital counter by 1, corresponding to 0.1km.

The prototype used a 3-digit LED counter to provide a readout for the odometer but a cheap calculator could also be used to perform the counting function (see SILICON CHIP, May 2003).

Tony Verberne,
Ivanhoe, Vic. ($40)

```
'                    ****************************************
'                    *      Bicycle Odometer Program        *
'                    ****************************************
'*********************************************************************
'*The program sends a 1 ms pulse to a counter every 100 metres. It is assumed that *
'*the wheel diameter is 70 cm. The circumference is then 2.2 m. The bicycle travels *
'*100 m in 100/2.2 = 45.5 rotations of the wheel. Each rotation is sensed by a reed *
'*switch which is activated by a magnet mounted on the spokes. Pulses from the reed *
'*switch are counted in software by the PicAxe program. Every 45 or 46 rotations, a *
'*pulse is sent to a counter. This fixes the 45.5 turns problem. This calibration can be *
'*changed to suit other wheel diameters. Although the output of the PicAxe chip can *
'*be counted with a digital counter, another option is to use a cheap, small calculator *
'* to perform the counting task. The calculator is initialised using a sequence of *
'* commands from the outputs of the PicAxe chip. *
'*********************************************************************
'
symbol counter1 = b0                    'set initial conditions for counter
symbol flag1 = b1                       'and flag1
b0 = 0
b1 = 0
main:
If pin3 =1 and flag1 = 0 then Inc1      'check for pulse from reed switch
If pin3 =1 and flag1 = 1 then Inc2      'if high go to Inc1 or Inc2 routine

goto main                               'if low cycle again

Inc1:                                   'counter for 0.70 m wheel diameter

counter1 = counter1 + 1                 'increment counter with each rotation
pulsout 2, 100                          'send 1 ms pulse to pin 2 of
                                        'microcontroller chip to reset flipflop
If counter1 = 45 then Puls              'test for 45 counts (~ 100 m distance)

goto main                               'return to main program

Inc2:                                   'counter for 0.70 m wheel diameter

counter1 = counter1 + 1                 'increment counter with each rotation
pulsout 2, 100                          'send 1 ms pulse to pin 2 of
                                        'microcontroller chip to reset flipflop
If counter1 = 46 then Puls              'test for 46 counts (~ 100 m distance)
goto main                               'return to main program

Puls:
pulsout 4, 100                          'send 1 ms pulse to pin 4 of the
                                        'microcontroller chip

b0 = 0                                  'reset counter1 to zero

If flag1 = 0 then flaga                 'conditionally reset flag
If flag1 = 1 then flagb

flaga:
flag1 =1
goto main
flagb:
flag1 = 0
goto main

'Notes: After counter1 is reset, a pulse is sent to pin2 which then resets the flipflop. The
'flipflop is also connected to the reed switch. This avoids retrigger from one wheel rotation.
```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November 1997: Build A Colour TV Pattern Generator, Pt.1; A Junkbox 2-Valve Receiver; Flashing Alarm Light For Cars; Digital Altimeter For Gliders, Pt.3; Build A Talking Voltmeter For Your PC, Pt.2.

December 1997: TV Transmitter For VCRs With UHF Modulators; IR Light Beam Relay; Colour TV Pattern Generator, Pt.2; Index To Vol.4.

March 1998: TV Transmitter For VHF VCRs; Thermostatic Switch For Car Radiator Fans; Valve Substitution In Vintage Radios.

April 1998: IR Remote Control For Model Railroads; Differential Input Buffer For CROs; Understanding Computer Memory; Aligning Vintage Radio Receivers, Pt.1.

June 1998: Multi-Station Headset Intercom, Pt.1; Video Switcher For Camcorders & VCRs; IR Remote Control For Model Railroads, Pt.3; 15-Watt 12-240V Inverter; A Look At Hard Disk Drives.

October 1998: 2kW 24VDC - 240VAC Sinewave Inverter; Multi-Sector Home Burglar Alarm, Pt.2; Mini Amplifier For Personal Stereos; A Regulated Lead-Acid Battery Charger.

February 1999: Three Projects For Model Railroads: Low Fuel Indicator For Cars; Audio Level/VU Meter (LED Readout); An Electronic Cockroach; 2kW 24VDC To 240VAC Sinewave Inverter, Pt.5.

March 1999: Solar Charger For 12V Batteries; Alarm-Triggered Security Camera; Speaker Protector; Audio Mixer for Camcorders; A 24-Hour Sidereal Clock For Astronomers.

April 1999: Solar-Powered Electric Fence; Audio Power Meter; Three-Function Home Alarm; Induction, 12VDC To 70VDC Converter; Digital Clock With Battery Back-Up.

June 1999: AM Radio Trainer, Pt.1; Remote Control For The Woofer Stopper; Digital Voltmeter For Cars; Windows-Based Logic Analyser.

July 1999: Single Chip Message Recorder; Light Beam Relay Extender; AM Radio Trainer, Pt.2; Quiz Game Adjudicator; Windows-Based Logic Analyser, Pt.2; Antenna Tuners – Why They Are Useful.

August 1999: Low-Cost Colour Video Fader; 60-LED Brake Light Array; Microprocessor-Based Sidereal Clock; Satellites & Their Orbits.

September 1999: Automatic Nicad Battery Charger/Discharger; Stereo Preamplifier With IR Remote Control, Pt.1; In-Circuit Transistor Tester; +5V to +15V DC Converter; Remote-Controlled Cockroach.

October 1999: Courtesy Light Switch-Off Timer For Cars; Wireless Microphone For Musicians; Stereo Preamplifier With IR Remote Control, Pt.2; Electronic Engine Management, Pt.1.

November 1999: High-Efficiency Inverter For Fluorescent Tubes; Stereo Preamplifier With IR Remote Control, Pt.3; Siren Sound Generator; Engine Management, Pt.2; Experiments For Games Cards.

December 1999: Remote Controller For Garage Doors; Build A LED Stroboscope; Build A 25W Audio Amplifier Module; A 1-Chip Melody Generator; Engine Management, Pt.3; Index To Volume 6.

January 1994: 3A 40V Variable Power Supply; Solar Panel Switching Regulator; Printer Status Indicator; Mini Drill Speed Controller; Stepper Motor Controller; Active Filter Design; Engine Management, Pt.4.

February 1994: Build A 90-Second Message Recorder; 12-240VAC 200W Inverter; 0.5W Audio Amplifier; 3A 40V Adjustable Power Supply; Engine Management, Pt.5; Airbags In Cars – How They Work.

March 1994: Intelligent IR Remote Controller; 50W (LM3876) Audio Amplifier Module; Level Crossing Detector For Model Railways; Voice Activated Switch For FM Microphones; Engine Management, Pt.6.

April 1994: Sound & Lights For Model Railway Level Crossings; Discrete Dual Supply Voltage Regulator; Universal Stereo Preamplifier; Digital Water Tank Gauge; Engine Management, Pt.7.

May 1994: Fast Charger For Nicad Batteries; Induction Balance Metal Locator; Multi-Channel Infrared Remote Control; Dual Electronic Dice; Simple Servo Driver Circuits; Engine Management, Pt.8.

June 1994: A Coolant Level Alarm For Your Car; 80-Metre AM/CW Transmitter For Amateurs; Converting Phono Inputs To Line Inputs; PC-Based Nicad Battery Monitor; Engine Management, Pt.9.

July 1994: Build A 4-Bay Bow-Tie UHF TV Antenna; PreChamp 2-Transistor Preamplifier; Steam Train Whistle & Diesel Horn Simulator; 6V SLA Battery Charger; Electronic Engine Management, Pt.10.

August 1994: High-Power Dimmer For Incandescent Lights; Dual Diversity Tuner For FM Microphones, Pt.1; Nicad Zapper (For Resurrecting Nicad Batteries); Electronic Engine Management, Pt.11.

September 1994: Automatic Discharger For Nicad Batteries; Mini/Vox Voice Operated Relay; AM Radio For Weather Beacons; Dual Diversity Tuner For FM Mics, Pt.2; Electronic Engine Management, Pt.12.

October 1994: How Dolby Surround Sound Works; Dual Rail Variable Power Supply; Build A Talking Headlight Reminder; Electronic Ballast For Fluorescent Lights; Electronic Engine Management, Pt.13.

November 1994: Dry Cell Battery Rejuvenator; Novel Alphanumeric Clock; 80-Metre DSB Amateur Transmitter; Twin-Cell Nicad Discharger (See May 1993); How To Plot Patterns Direct to PC Boards.

December 1994: Easy-To-Build Car Burglar Alarm; Three-Spot Low Distortion Sinewave Oscillator; Clipford – A Pesky Electronic Cricket; Remote Control System for Models, Pt.1; Index to Vol.7.

January 1995: Sun Tracker For Solar Panels; Battery Saver For Torches; Dolby Pro-Logic Surround Sound Decoder, Pt.2; Dual Channel UHF Remote Control; Stereo Microphone Preamplifier.

February 1995: 2 x 50W Stereo Amplifier Module; Digital Effects Unit For Musicians; 6-Channel Thermometer With LCD Readout; Wide Range Electrostatic Loudspeakers, Pt.1; Oil Change Timer For Cars; Remote Control System For Models, Pt.2.

March 1995: 2 x 50W Stereo Amplifier, Pt.1; Subcarrier Decoder For FM Receivers; Wide Range Electrostatic Loudspeakers, Pt.2; IR Illuminator For CCD Cameras; Remote Control System For Models, Pt.3.

April 1995: FM Radio Trainer, Pt.1; Balanced Mic Preamp & Line Filter; 50W/Channel Stereo Amplifier, Pt.2; Wide Range Electrostatic Loudspeakers, Pt.3; 8-Channel Decoder For Radio Remote Control.

May 1995: Build A Guitar Headphone Amplifier; FM Radio Trainer, Pt.2; Transistor/Mosfet Tester For DMMs; A 16-Channel Decoder For Radio Remote Control; Introduction to Satellite TV.

June 1995: Build A Satellite TV Receiver; Train Detector For Model Railways; 1W Audio Amplifier Trainer; Low-Cost Video Security System; Multi-Station Intercom System For Models, Pt.1.

July 1995: Electric Fence Controller; How To Run Two Trains On A Single Track (incl. Lights & Sound); Setting Up A Satellite TV Ground Station; Build A Reliable Door Minder.

August 1995: Fuel Injector Monitor For Cars; Gain Controlled Microphone Preamp; Audio Lab PC-Controlled Test Instrument, Pt.1; How To Identify IDE Hard Disk Drive Parameters.

September 1995: Railpower Mk.2 Walkaround Throttle For Model Railways, Pt.1; Kiyanti Computer Voice Changer; The Vader Voice; Jacob's Ladder Display; Audio Lab PC-Controlled Test Instrument, Pt.2.

October 1995: 3-Way Loudspeaker System; Railpower Mk.2 Walkaround Throttle For Model Railways, Pt.2; Build A Fast Charger For Nicad Batteries.

November 1995: Mixture Display For Fuel Injected Cars; CB Transverter For The 80M Amateur Band, Pt.1; PIR Movement Detector.

December 1995: Engine Immobiliser; 5-Band Equaliser; CB Transverter For The 80M Amateur Band, Pt.2; Subwoofer Controller; Knock Sensing In Cars; Index To Volume 8.

January 1996: Surround Sound Mixer & Decoder, Pt.1; Magnetic Card Reader; Build An Automatic Sprinkler Controller; IR Remote Control For The Railpower Mk.2; Recharging Nicad Batteries For Long Life.

April 1996: 125W Audio Amplifier Module; Knock Indicator For Leaded Petrol Engines; Multi-Channel Radio Control Transmitter, Pt.3.

May 1996: High Voltage Insulation Tester; Knightrider LED Chaser; Simple Intercom Uses Optical Cable; Cathode Ray Oscilloscopes, Pt.3.

June 1996: Stereo Simulator (uses delay chip); Rope Light Chaser; Low Ohms Tester For Your DMM; Automatic 10A Battery Charger.

July 1996: Build A VGA Digital Oscilloscope, Pt.1; Remote Control Extender For VCRs; 2A SLA Battery Charger; 3-Band Parametric Equaliser; Single Channel 8-Bit Data Logger.

August 1996: Introduction to IGBTs; Electronic Starter For Fluorescent Lamps; VGA Oscilloscope, Pt.2; 350W Amplifier Module; Masthead Amplifier For TV & FM; Cathode Ray Oscilloscopes, Pt.4.

September 1996: VGA Oscilloscope, Pt.3; IR Stereo Headphone Link, Pt.1; High Quality PA Loudspeaker; 3-Band HF Amateur Radio Re-

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ceiver; Cathode Ray Oscilloscopes, Pt.5.

October 1986: Send Video Signals Over Twisted Pair Cable; Power Control With A Light Dimmer; 600W DC-DC Converter For Car Hifi Systems, Pt.1; IR Stereo Headphone Link, Pt.2; Build A Multi-Media Sound System, Pt.1; Multi-Channel Radio Control Transmitter, Pt.8.

November 1986: 8-Channel Stereo Mixer, Pt.1; Low-Cost Fluorescent Light Inverter; Repairing Domestic Light Dimmers; Multi-Media Sound System, Pt.2; 600W DC-DC Converter For Car Hifi Systems, Pt.2.

December 1986: Active Filter Cleans Up Your CW Reception; A Fast Clock For Railway Modellers; Laser Pistol & Electronic Target; Build A Sound and Light Effects Modulator, Pt.2; Index To Vol 8.

January 1987: How To Network Your PC; Control Panel For Multiple Smoke Alarms, Pt.1; Build A Pink Noise Source; Computer Controlled Dual Power Supply, Pt.1; Dig-Temp Monitors Eight Temperatures.

February 1987: PC-Controlled Moving Message Display; Computer Controlled Dual Power Supply, Pt.2; Alert-A-Phone; Loud Speaker Telephone Alarm; Control Panel For Multiple Smoke Alarms, Pt.2.

March 1987: Driving A Computer By Remote Control; Plastic Power PA Amplifier (175W); Signalling & Lighting For Model Railways; Build A Jumbo LED Clock; Stabilised Power Supplies, Pt.7.

April 1987: Simple Timer With No ICs; Digital Voltmeter For Cars; Loudspeaker Protector For Stereo Amplifiers; Model Train Controller; A Look At Signal Tracing; Pt.1; Cathode Ray Oscilloscopes, Pt.8.

May 1987: Neon Tube Modulator For Light Systems; Traffic Lights For A Model Railway; Using Microdrives; Why Write Messages In Thin Air; A Look At Signal Tracing; Pt.2; Cathode Ray Oscilloscopes, Pt.9.

June 1987: PC-controlled Thermometer/Thermostat; TV Pattern Generator, Pt.1; Audio/RF Signal Tracer; High-Current Speed Controller For 12V/24V Motors; Manual Control Circuit For Stepper Motors.

July 1987: Infrared Remote Volume Control; A Flexible Interface Card For PCs; Points Controller For Model Railways; Colour TV Pattern Generator, Pt.2; An In-Line Monitor For Audio Signals.

August 1987: The Bass Barrel Subwoofer; 500 Watt Audio Power Amplifier Module; A TENs Unit For Pain Relief; Addressable PC Card For Stepper Motor Control; Remote Controlled Gates For Your Home.

September 1987: Multi-Spark Capacitor Discharge Ignition; 500W Audio Power Amplifier, Pt.2; A Versatile Speech Compressor; Using Microdrives; PC Card For Controlling Two Stepper Motors; HiFi On A Budget.

October 1987: Build A 5-Digit Tachometer; Add Central Locking To Your Car; PC-Controlled 8-Channel Voltmeter; 500W Audio Power Amplifier, Pt.3; Customising The Sinclair QL Start Menu.

November 1987: Heavy Duty 10A 240VAC Motor Speed Controller; Easy-To-Use Cable & Wiring Tester; Build A Musical Doorbell; Replacing Foam Speaker Surrounds; Understanding Electric Lighting Pt.1.

December 1987: Speed Alarm For Cars; 2-Axis Robot With Gripper; Stepper Motor Drive Module; Power Supply For Stepper & Servo Motor Cards; Understanding Electric Lighting Pt.2; Index To Vol.10.

January 1988: Build Your Own 4-Channel Lightshow. Pt.1 (runs off 12VDC or 12VAC); Command Control System For Model Railways, Pt.1; Pan Controller For CCD Cameras.

February 1988: Multi-Purpose Fast Battery Charger, Pt.1; Telephone Exchange Simulator For Testing; Command Control System For Model Railways, Pt.2; Build Your Own 4-Channel Lightshow, Pt.2

April 1988: Automatic Garage Door Opener; Pt.1; 40V 8A Adjustable Power Supply, Pt.1; PC-Controlled 8-Channel Stereo Attenuator; Build A Laser Light Show; Understanding Electric Lighting; Pt.6.

May 1988: Troubleshooting Your PC, Pt.1; Build A 5-LED Logic Probe; Automatic Garage Door Opener, Pt.2; Command Control For Model Railways, Pt.4; 40V 8A Adjustable Power Supply, Pt.2.

June 1988: Troubleshooting Your PC, Pt.2; Universal High Energy Ignition System; The Roadies' Friend Cable Tester; Universal Stepper Motor Controller; Command Control For Model Railways, Pt.5.

July 1988: Troubleshooting Your PC, Pt.3; 15W/Ch Class-A Audio Amplifier, Pt.1; Simple Charger For 6V & 12V SLA Batteries; Automatic Semiconductor Analyser; Understanding Electric Lighting, Pt.8.

August 1988: Troubleshooting Your PC, Pt.4 (Adding Extra Memory); Simple I/O Card With Automatic Data Logging; Build A Beat Triggered Strobe; 15W/Ch Class-A Stereo Amplifier, Pt.2.

September 1988: Troubleshooting Your PC, Pt.5; A Blocked Air-Filter Alarm; Wax-Wad Pedal For Guitars; Jacob's Ladder; Gear Change Indictor For Cars; Capacity Indicator For Rechargeable Batteries.

October 1988: AC Millivoltmeter, Pt.1; PC-Controlled Stress-O-Meter; Versatile Electronic Guitar Limiter; 12V Trickle Charg-er For Float Conditions; Adding An External Battery Pack To Your Flashgun.

November 1988: The Christmas Star; A Turbo Timer For Cars; Build A Power Machine, Pt.1; FM Transmitter For Musicians; Lab Quality AC Millivoltmeter, Pt.2; Improving AM Radio Reception, Pt.1.

December 1988: Engine Immobiliser Mk.2; Thermocouple Adaptor For DMMs; Regulated 12V DC Plugpack; Build A Power Machine, Pt.2; Improving AM Radio Reception, Pt.2; Mixer Modules For F3B Gliders.

January 1989: High-Voltage Megohm Tester; Getting Started With BASIC Stamp; LED Bargraph Ammeter For Cars; Keypad Engine Immobiliser; Improving AM Radio Reception, Pt.3.

March 1989: Getting Started With Linux; Pt.1; Build A Digital Anemometer; Simple DIY PIC Programmer; Easy-To-Build Audio Compressor; Low Distortion Audio Signal Generator, Pt.2.

April 1989: Getting Started With Linux, Pt.2; High-Power Electric Fence Controller; Bass Cube Subwoofer; Programmable Thermostat/ Thermometer; Build An Infrared Sentry; Rev Limiter For Cars.

May 1989: The Line Dancer Robot; An X-Y Table With Stepper Motor Control, Pt.1; Three Electric Fence Testers; Heart Of LEDs; Build A Carbon Monoxide Alarm; Getting Started With Linux; Pt.3.

June 1989: FM Radio Tuner Card For PCs; X-Y Table With Stepper Motor Control, Pt.2; Programmable Ignition Timing Module For Cars, Pt.1; Hard Disk Drive Upgrades Without Reinstalling Software?

July 1989: Build A Dog Sitter; 10µH to 19.99mH Inductance Meter; Build An Audio/Video Signal Booster Amplifier; Ignition Timing Module For Cars, Pt.2; XYZ Table With Stepper Motor Control, Pt.3.

August 1989: Remote Modem Controller; Daytime Running Lights For Cars; Build A PC Monitor Checker; Switching Temperature Controller; XYZ Table With Stepper Motor Control, Pt.4; Electric Lighting, Pt.14.

September 1989: Autonomouse The Robot, Pt.1; Voice Direct Speech Recognition Module; Digital Electrolytic Capacitance Meter; XYZ Table With Stepper Motor Control, Pt.5; Build A Computer Cool-ing Cooler.

October 1989: Build The Railpower Model Train Controller, Pt.1; Semiconductor Curve Tracer; Autonomouse The Robot, Pt. XYZ Table With Stepper Motor Control, Pt.6; Introducing Home Theatre.

November 1989: Setting Up An Email Server; Speed Alarm For Cars, Pt.1; LED Christmas Tree; Infrasonic Station Encoder; Foldback Loudspeaker System; Railpower Model Train Controller, Pt.2.

December 1989: Solar Panel Regulator; PC Powerhouse (gives +12V +9V, -9V & +5V rails); Fortune Finder Metal Locator; Speed Alarm For Cars, Pt.2; Railpower Model Train Controller, Pt.3; Index To Vol.12.

January 2000: Spring Reverberation Module; An Audio-Video Test Generator; Build The Picman Programmable Robot; A Parallel Port Interface Card; Off-Hook Indicator For Telephone Lines.

February 2000: Multi-Sector Sprinkler Controller; A Digital Voltmeter For Your Car; An Ultrasonic Intruder Alarm; Build A Safety Switch Checker; Build A Sine/Square Wave Oscillator.

March 2000: Resurrecting An Old Computer; Low Distortion 100W Amplifier Module, Pt.1; Electronic Wind Vane With 16-LED Display; Glowplug Driver For Powered Model Aircraft; The Serial Port.

May 2000: Ultra-LD Stereo Amplifier, Pt.2; Build A LED Dice (With PIC Microcontroller); Low-Cost AT Keyboard Translator (Converts IBM Scan-Codes To ASCII); 50A Motor Speed Controller For Models.

June 2000: Automatic Rain Gauge With Digital Readout; Parallel Port VHF FM Receiver; Ultra-LD Stereo Amplifier, Pt.3; Linear Supply (1.23V to 40V) Pt.1; CD Compressor For Cars Or The Home.

July 2000: A Moving Message Display; Compact Fluorescent Lamp Driver; El-Cheapo Musical Doorbell; Low-Cost Timer; Li'l Powerhouse Switchmode Power Supply (1.23V to 40V) Pt.2.

August 2000: Build A Theremin For Really Eerie Sounds; Come In Spinner (writes messages in "thin-air"); Proximity Switch For 240VAC Lamps; Structured Cabling For Computer Networks.

September 2000: Build A Swimming Pool Alarm; An 8-Channel PC Relay Board; Fuel Mixture Displays For Cars, Pt.1; Protobards – The Easy Way Into Electronics, Pt.1; Cybug The Solar Fly.

October 2000: Guitar Jammer For Practice & Jam Sessions; Boost Buster Engine Tester; 4 Watt Audio Amplifier Module; Analysing A Free-Air Subwoofer In Your Car; Fuel Mixture Display For Cars, Pt.2.

November 2000: Santa & Rudolf Chrissie Display; 2-Channel Guitar Preamplifier, Pt.1; Message Bank & Missed Call Alert; Protoboards – The Easy Way Into Electronics, Pt.2.

December 2000: Home Networking For Shared Internet Access; Build A Bright-White LED Torch; 2-Channel Guitar Preamplifier, Pt.2 (Digital Reverb); Driving An LCD From The Parallel Port; Index To Vol.13.

January 2001: How To Transfer LPs & Tapes To CD; The LP Doctor – Clean Up Clicks & Pops, Pt.1; Arbitrary Waveform Generator; 2-Channel Guitar Preamplifier, Pt.3; PIC Programmer & TestBed.

February 2001: An Easy Way To Make PC Boards; Li'l Pulser Train Controller; A MIDI Interface For PCs; Build The Bass Blazer; 2-Metre Groundplane Antenna; The LP Doctor – Clean Up Clicks & Pops, Pt.2.

March 2001: Making Photo Resist PC Boards; Big-Digit 12/24 Hour Clock; Parallel Port PIC Programmer & Checkerboard; Protoboards – The Easy Way Into Electronics, Pt.5; A Simple MIDI Expansion Box.

April 2001: A GPS Module For Your PC; Dr Video – An Easy-To-Build Video Stabiliser; Tremolo Unit For Musicians; Minimitter FM Stereo Transmitter; Intelligent Nicad Battery Charger.

May 2001: Powerful 12V Mini Stereo Amplifier; Two White-LED Torches To Build; PowerPak – A Multi-Voltage Power Supply; Using Linux To Share An Internet Connection, Pt.1; Tweaking Windows With Tweak UI.

June 2001: Fast Universal Battery Charger, Pt.1: Phonome – Call, Listen In & Switch Devices On & Off; Li'l Snooper – A Low-Cost Automatic Camera Switcher; Using Linux To Share An Internet Connection, Pt.2; A PC To Die For, Pt.1 (Building Your Own PC).

July 2001: The HeartMate Heart Rate Monitor; Do Not Disturb Telephone Timer; Pic-Toc – A Simple Alarm Clock; Fast Universal Battery Charger, Pt.2; A PC To Die For, Pt.2; Backing Up Your Email.

August 2001: DI Box For Musicians; 200W Model Amplifier Module; Headlight Reminder; 40MHz 6-Digit Frequency Counter Module; A PC To Die For, Pt.3; Using Linux To Share An Internet Connection, Pt.3.

September 2001: Making MP3s – Rippers & Encoders; Build Your Own MP3 Jukebox, Pt.1; PC-Controlled Mains Switch; Personal Noise Source For Tinnitus Sufferers; The Sniper Shot Stopper Direct-Control Microphone; Using Linux To Share An Internet Connection, Pt.4.

November 2001: Ultra-LD 100W RMS/Channel Stereo Amplifier, Pt.1; Neon Tube Modulator For Cars; Low-Cost Audio/Video Distribution Amplifier; Short Message Recorder Player; Computer Tips.

December 2001: A Look At Windows XP; Build A PC Infrared Transceiver; Ultra-LD 100W RMS/Ch Stereo Amplifier, Pt.2; Pardy Lights – An Intriguing Colour Display; PIC Fun – Learning About Micros.

January 2002: Touch And/Or Remote-Controlled Light Dimmer, Pt.1; A Cheap Yet Versatile Audio Amplifier Module; 100W RMS/Channel Amplifier, Pt.3; Build A Raucous Alarm; FAQs On The MP3 Jukebox.

February 2002: 10-Channel IR Remote Control Receiver; 2.4GHz High-Power Audio/Video Link; Assemble Your Own 240V Power Speakers; Touch And/Or Remote-Controlled Light Dimmer, Pt.2; Booting A PC Without A Keyboard; 4-Way Event Timer.

March 2002: Mighty Midget Audio Amplifier Module; The Itsy-Bitsy USB Lamp; 6-Digit IR Remote Volume Control; Ultra-LD Mk.3 Pre-Amplifier For Magnetic Cartridges; 12/24V Intelligent Solar Power Battery Charger; Generate Audio Tones Using Your PC's Soundcard.

April 2002: Automatic Single-Channel Light Dimmer; Pt.1; Build A Water Level Indicator; Multiple-Output Bench Power Supply; Versatile Multi-Mode Timer; 6-Channel IR Remote Volume Control, Pt.2.

May 2002: 32-LED Knightrider; The Battery Guardian (Cuts Power When the Battery Voltage Drops); Stereo Headphone Amplifier; Automatic Single-Channel Light Dimmer; Pt.2; Stepper Motor Controller.

June 2002: Lock Out The Bad Guys with A Firewall; Remote Volume Control For Stereo Amplifiers; The "Matchless" Metal Locator; Compact 0-80A Automotive Ammeter; Constant High-Current Source.

July 2002: Telephone Headset Adaptor; Rolling Code 4-Channel UHF Remote Control; Remote Volume Control For The Ultra-LD Stereo Amplifier; Direct Conversion Receiver For Radio Amateurs, Pt.1.

August 2002: Digital Instrumentation Software For Your PC; Digital Storage Logic Probe; Battery Charger/Thermostat/Timer; Nicad Cell Interface For PC Test Instruments; Direct Conversion Receiver For Radio Amateurs, Pt.2; Spruce Up Your PC With XP-Style Icons.

September 2002: 12V Fluorescent Lamp Inverter; 8-Channel Infrared Remote Control; 50-Watt DC Electronic Load; Driving Light & Accessory Protector For Cars; Spyware – An Update.

October 2002: Speed Controller For Universal Motors; PC Parallel Port Wizard; "Whistle & Point" Cable Tracer; Build An AVR ISP Serial Programmer; Ultra-LD 2.5 For Your Own Home.

November 2002: SuperCharger For NiCd/NiMH Batteries, Pt.1; Windows-Based EPROM Programmer, Pt.1; 4-Digit Crystal-Controlled Timing Module; Using Linux To Share An Optus Cable Modem, Pt.1.

December 2002: Receiving TV From Satellites, Pt.1; The Micromitter Stereo FM Transmitter; Windows-Based EPROM Programmer, Pt.2; SuperCharger For NiCd/NiMH Batteries, Pt.2; Simple VHF FM/AM Radio; Using Linux To Share An Optus Cable Modem, Pt.2.

January 2003: Receiving TV From Satellites, Pt.2; SC480 50W RMS Amplifier Module, Pt.1; Gear Indicator For Cars; Active 2-Way Crossover For Speakers; Using Linux To Share An Optus Cable Modem, Pt.3.

February 2003: The PortaPal Public Address System, Pt.1; 240V Mains Filter For Hifi Systems; SC480 50W RMS Amplifier Module, Pt.2; Windows-Based EPROM Programmer, Pt.3; Using Linux To Share An Optus Cable Modem, Pt.4; Tracking Down Elusive PC Faults.

March 2003: LED Lighting For Your Car; Peltier-Effect Tinnie Cooler; PortaPal Public Address System, Pt.2; 12V SLA Battery Float Charger; Build The Little Dynamite Subwoofer; Fun With The PICAXE (Build A Shop Door Minder); SuperCharger Addendum; Emergency Beacons.

April 2003: Video-Audio Booster For Home Theatre Systems; A Highly-Flexible Keypad Alarm; Telephone Dialler For Burglar Alarms; Three-In-It-Yourself PIC Programmer Kits; More Fun With The PICAXE, Pt.3 (Heartbeat Simulator); Electric Shock Generator For Cunning.

May 2003: Widgibox Guitar Distortion Effects Unit; 10MHz Direct Digital Synthesis Generator; Big Blaster Subwoofer; Printer Port Simulator; More Fun With The PICAXE, Pt.4 (Motor Controller).

June 2003: More Fun With The PICAXE, Pt.5; PICAXE-Controlled Telephone Intercom; PICAXE-08 Port Expansion Board; Sound Effects For Security & Garden Lighting; Digital Reaction Timer; Adjustable DC-DC Converter For Cars; Long-Range 4-Channel UHF Remote Control.

July 2003: Smart Card Reader & Programmer; Power-Up Auto Mains Switch; A "Smart" Slave Flash Trigger; Programmable Continuity Tester; PICAXE Pt.6 – Data Communications; Updating The PIC Programmer & Checkerboard; RFID Tags – How They Work.

August 2003: PC Infrared Remote Receiver (Play DVDs & MP3s On Your PC Via Remote Control); Digital Instrument Display For Cars, Pt.1; Home-Brew Weatherproof 2.4GHz WiFi Antennas; PICAXE Pt.7 – Get That Clever Clock Operating System; A Digital Timer For Less Than $20.

September 2003: Robot Wars – The Sport Of The New Millenium; Bright & Cheap Krypton Bike Light; Portable PIC Programmer; Current Clamp Meter Adapter For DMMs; PICAXE Pt.8 – A Data Logger & Sending It To Sleep; Digital Instrument Display For Cars, Pt.2.

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24V versions of LED modules wanted

Why is it that the LED lamp modules for cars, featured in the March 2003 issue, are only for 12V systems! Many of my mates read SILICON CHIP and drive different makes of trucks and have asked me if they these modules could be used in a 24V system. So would you consider publishing the 24V component list for these modules? (C. S., via email).

● Unfortunately, it is not a simple matter to produce 24V versions of the various LED lamps. That's because increasing the values of the current limiting resistors means than power dissipation becomes excessive in the limited space available.

A better solution would be to have longer series LED strings to run from the higher voltage but that is not easily done with any of the existing PC boards.

No sparks on Jacob's Ladder

I recently purchased the "Jacobs Ladder" kit (SILICON CHIP, September 1995) from a local Jaycar store.

I have come across a slight problem. Everything is as it should be but when connected to a brand new 12V car battery, there are no sparks sent up the ladder itself. I have checked it over more than once. So what do I do now? (C. W., via email).

● You will have to do some troubleshooting. For example, is there a low voltage at the collector of Q2? If so, try shorting its base to the emitter. This should give a single spark.

If that happens, you have a fault in IC1 or Q1. You will need to do this process of elimination to find the fault. Also, use your multimeter (Ohms) to check that the ignition coil is OK.

No quiescent current in amplifier

I am building the SC480 amplifier at the moment. I have done all the tests, bar one, where you must wind trimpot VR1 to make the resistors have 28V across them. However, VR1 has no effect whatsoever. Any ideas? (P. Z., via email).

● It sounds as though you might have a short in the Vbe multiplier circuit involving Q7. Either the transistor itself is short circuit between collector and emitter or there is a solder splash on the board shorting the collector to base (turning the transistor fully on) or between collector and emitter.

Another possibility is that you have an open circuit in the connection between base, the 100Ω resistor and VR1. Again, this will turn the transistor (Q7) fully on and there will be no adjustment possible; ie, zero quiescent current.

Servo control with a potentiometer

I am looking for a circuit or design that can smoothly control a servo motor (as used in R/C cars) by using a potentiometer. Would the circuit in the May 1994 issue cover this? (S. S., Brisbane, Qld).

● The May 1994 circuit will do it or you can look at the Jumbo servo in the May 2001 issue. There is also a dual servo control for panning a video camera in the January 1998 issue.

Dancing waters display

I am attempting to make a "Dancing Waters" project. I saw this in America a long time ago (40 years). It consisted of jets of water which oscillate in tune with music played in the control box.

My memory of the details are hazy but I imagine the jets rose higher as the music note became higher and more water flowed when the music was louder. A friend suggested that a Musicolour ("Electronics Australia", September 1976) could serve this purpose.

I intend to control the oscillation of the jets with a variable speed motor, preferably at low voltage. A system of coloured lights on the PC board would be an advantage.

Basically, I need a PC board which will "read" the frequency and voltage of the current going to the speaker and

Phasing in a 4-bay bow-tie antenna

Some years ago, I came across an article from the July 1994 issue about building a 4-bay bow-tie outdoor UHF TV antenna. I was more interested in the theory than in building, however I have a question for the authors of the article.

Ready-made bow-tie antennas are not easy to find in the USA and maybe elsewhere as well. However, there is a readily available 2-bay bow-tie which is actually made for indoor use but I have discovered that it will work outside.

I have two such antennas. They are made by Radio Shack, an electronics store common in the USA.

Could two or more of these 2-bay bow-ties be linked together to make a 4-bay bow-tie? If so, I presume the exact way they are connected together is critical.

Can you advise me how to do this if it is possible? (E. B., via email).

● You could conceivably connect two 2-bay antennas together but the phasing of the outside pair has to be reversed compared with the centre pair. You really need to have a look at how it is done with a 4-bay in order to understand.

Failing that, have close look at the dimensions on the design featured in the July 1994 issue.

convert it to current to operate motors and solenoids. Are you able to supply such a PC board and wiring diagram? (T. G., via email).

● Have a look at the 12V LightShow published in the January 1998 issue. It works from 12V AC or DC and is intended to drive halogen lamps but it could also drive 12V motors or solenoids provided they have reverse biased power diodes connected across them.

Converting phono inputs to line inputs

Like thousands of others, I've recently got a DVD player and I am currently playing DVD sound, CDs and MP3s through an old but good Leak stereo amplifier. The sound is really good but I would like to play it through my late model stereo system to allow selection and volume/mute control from the remote and get rid of the additional speakers.

The problem is, the only unused input available on my late model Sharp stereo system is the phono input which is not compatible with the DVD output, I think this is because the low level signal from the pick-up is preamplified before going into the main amplifier and now the DVD output overdrives it.

Is there a simple way to overcome this with a commercially available product or has SILICON CHIP had a kit which would do the job? I realise this won't give me "5.1 Home Theatre" sound which the DVD is capable of but until I have a serious upgrade, being able to play it through the Sharp would do me fine. (B. P., via email).

● Have a look at the inverse RIAA network published in the June 1994 issue. This is a passive network which converts RIAA phono inputs to line inputs.

We can supply the June 1994 issue for $8.80 including postage.

Problems with smart card kit

A few days ago, I purchased a Jaycar Smartcard reader/programmer kit (cat KC-5361). I had no problems assembling the kit and all of the tests recommended in the construction instructions were successful.

I downloaded and installed IC-Prog version 105a and the drivers for NT/XP. I have now spent days trying to read and/or write to the gold card (purchased at the same time as the kit). The settings are exactly as suggested in the instructions (3.58MHz, etc)

When I select read all, the reader returns all zeros. I have since discovered that IC-Prog does this even with no card inserted (or in fact, with no serial connection at all). I understand that a blank card does not return zeros. I have tried writing to the card – this seems to succeed until the verify, which fails at 0000h. When I use the card wizard, it fails at the card reset.

Here is what I have done thus far: (a) Using the 'Hardware Test" function of IC-Prog, I have tested the levels at the RS232 port on the circuit board and all is well; (b) I have checked every solder connection (26 times) visually and with a meter; (c) I have checked and re-checked every component for the correct value and orientation; (d) I have purchased three new ICs and replaced those; (e) I have purchased a new gold card; (f) I have re-tested the voltage levels as per the instructions; (g) I have replaced the power supply with a 9V battery; (h) I have read and re-read the instructions and the help file provided with IC-Prog; (i) I have tried using another

Garbage Day Reminder Settings Lost

I've been trying to find some info on my Garbage Day Reminder which was published in the August 1989 issue. I've had it running since 1990 and have just replaced the third set of batteries on it.

Unfortunately, I can't find a listing on it on your website. I've misplaced the magazine with the schematics and operating instructions. What I need to know is how do you set the day via the 8-way switch. It looks pretty easy to reset the thing but for some reason I cannot get it right the first time, every time.

I hope you can help me out, as I keep missing the garbage truck! I'm so used to that little flashing LED reminding me to put out the garbage. (A. M., via email).

● Link LK2 is for test purposes so that the circuit will run fast to test the operation of each LED. LK1 is used for normal operation.

When power is applied to the circuit (after changing batteries), the initial conditions are with the output of IC7 high and this will light the "Bin Out" LED if the first switch is closed. So the first switch is for the Day that the circuit is powered up and the next switches are for following days. The eighth switch does nothing. Also the LED will light at the time the circuit is reset.

So if you want the LED to light at 4pm, then apply power at 4pm. If for example, it is Sunday and the power is applied at 4pm, the "Bin Out" LED will light at 4pm for which ever day the switches are set. The first switch is for Sunday, the second for Monday, etc. If set at 4pm Wednesday, the first switch will be for Wednesday, the second for Thursday, etc.

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Small dynamo for tidal power

I have a 12V 10W solar panel on a small sailboat. However, on occasions it's cloudy and overcast so very little power comes from the panel. I am wondering about some type of small 12V dynamo, alternator or generator that I can adapt to wind or propeller power to supplement the solar panel.

If it provides up to 1A, that would be OK. The speed of rotation would be limited to about 200 RPM. I have in mind an outboard propeller coupled to the dynamo by a flexible hose and operating by spinning in the tidal flow when at anchor. The tides are quite strong here and provide a 3-4km/h current at anchor.

Is it true that a small brush-type electric motor can be used as a dynamo? I'm quite happy to adapt something as I have a small lathe and I am familiar with power supplies and rectification. (P. B., Maryborough, Qld).

● Any permanent magnet brush type motor can be used as a dynamo. However, you are not likely to get much output from any motor running at only 200 RPM. You will need a gearbox. A 12V windscreen or fan motor from a car could be a good start.

computer with a different OS; (j) I have tried all of this in both SmartMouse mode and Phoenix mode.

The results are always the same. I would be extremely grateful for any assistance you can give to help me resolve the problem. (G. M., via email).

● First up, note that a card that has not been successfully programmed (with the recommended loader) will always cause a "Card reset failed" error when trying to access the EEPROM.

Also, after opening the loader HEX file (but before attempting to write it to the PIC), make sure that the 'CP' (Code Protect) fuse bit is not enabled (ticked). If the PIC is inadvertently code protected, it will always read back as "zeros".

It should be possible to diagnose the problem using the procedure outlined below. Run throughout the tests once without a card in the socket and a second time with a blank Gold card inserted.

Important: the following tests assume that the board has successfully passed the voltage checks described in the kit instructions:

In PIC programming mode, four signals are controlled by the software to perform the necessary erase/program/verify. These are DATA OUT, DATA IN, CLOCK & MCLR/VPP. Each of these signals should be examined for correct operation. This can be achieved with an oscilloscope or logic probe and the "Hardware Check" dialog, accessible from the "Options" menu.

Testing the DATA OUT & DATA IN signals is straightforward. When you check (tick) the "Enable Data Out" option, a corresponding tick should appear in the "Data In" box. This is because the two are connected together at the junction of the 4.7kΩ & 470Ω resistors (connected to IC3e & IC3c). Verify that the signal arrives at the card socket's DATA (C7) pin.

The CLOCK signal can be checked by monitoring the card socket's CLK (C3) line and toggling the "Enable Clock" line. The signal should toggle between a valid logic '0' and logic '1'. Likewise for the MCLR/VPP (C2) line using "Enable MCLR", but this time the signal should swing between 13V and 0V.

Of course, the mode switch (S1) must be in the "PIC Programming" position (OUT) for the above checks.

Using the fuel mixture meter in an old car

I have built a fuel mixture kit but I was going to use it on an older pre-unleaded engine (1972 vintage car). I realise that the EGO sensor would be adversely effected by the lead tetraethyl additives that were used but what about the newer fuels; ie, the super lead-substitute fuels that do not use the older lead additives?

Can these newer fuels, that are specifically designed for pre-unleaded vehicle engines, be used longer term with the zirconia sensors or is it only short term as described? (R. Z., via email).

● Just use LRP (lead replacement petrol) and it will work fine.

Ethics of vintage radio restoration

I am attempting to restore a sentimental valve radio and have a question. On top of the chassis, there is a can capacitor, labelled Ducon 8 mfd. What are the correct "vintage radio ethics" for replacing this? Do you leave a hole there and replace it with an axial capacitor or try to get a capacitor of that voltage and dimension to replicate the original? (C. B., via email).

● What most restorers try to do is to preserve the look of the set, as seen from the top of the chassis. Therefore, you should leave the faulty capacitor on the chassis (but disconnected) and install the new (much smaller) one under the chassis. SC

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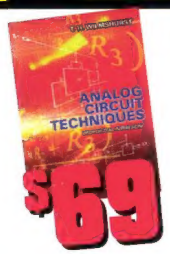

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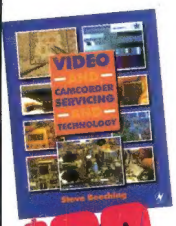

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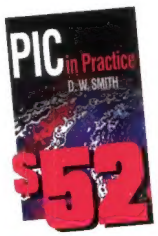

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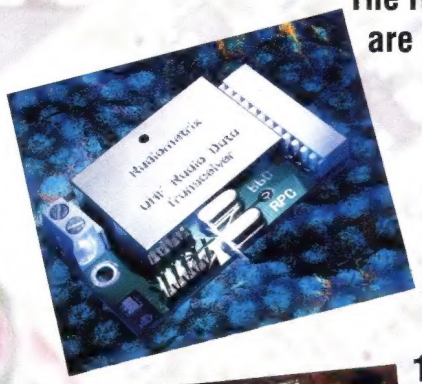

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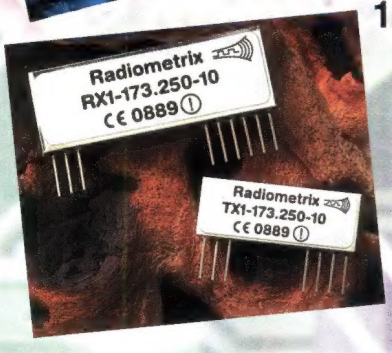

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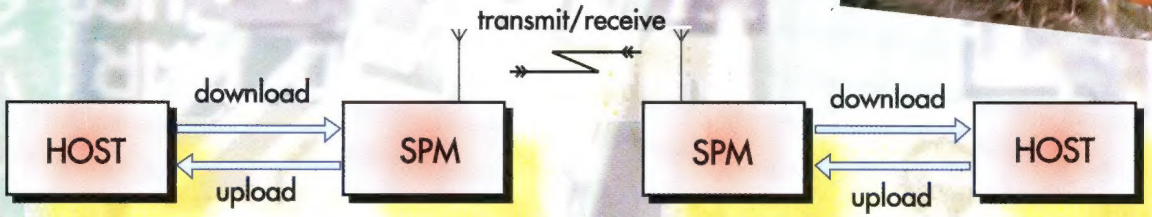

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